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Protein from the Sea

The Global Rise of Fishmeal and the Industrialization of Southeast Pacific Fisheries, 1918-1973

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The Global Rise of Fishmeal and the Industrialization of Southeast Pacific Fisheries, 1918-1973

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Abstract

This paper examines why and how, amidst efforts to combat malnutrition both locally and globally, the post-World War II industrialization of Peruvian and Chilean fisheries focused ultimately on fishmeal production for animal feed. It highlights the transnational entanglements among the visions of key individuals and institutions in the emerging postwar international order and explains how these impacted fisheries development at the local scale. Despite technical assistance programs by the United Nations Food and Agricultural Organization that aimed to create local markets and use fish proteins to ameliorate malnutrition, industrialists from both North and South saw greater potential in fishmeal as an export commodity for farmed chickens, hogs, and later fish. By 1972, when the Peruvian anchoveta collapsed, the coastal waters off Peru and Chile had become the world's primary source of concentrated fish proteins – a hidden but key ingredient in the global industrial food web – with serious consequences for local social and economic inequalities.

Keywords: fisheries | environmental history | environmental inequalities

Biographical Notes

Kristin Wintersteen received her Ph.D. (2011) in Latin American History from Duke University. Her dissertation, "Fishing for Food and Fodder: The Transnational Environmental History of Fishmeal in Peru and Chile since 1945", explored the history of industrial fisheries in the Humboldt Current marine ecosystem, where shifting ecological dynamics profoundly shaped – and were shaped by – human and animal food webs, both globally and in the coastal cities that depended on fishmeal production. From June through November, 2011, Kristin participated in the desiguALdades.net Research Dimension III: Socio-Ecological Inequalities as a short-term doctoral fellow. She currently holds a postdoctoral fellowship at the Stone Center for Latin American Studies, Tulane University, in New Orleans, LA, where she teaches courses on Latin American environmental history.

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1. Introduction

An ambitious mission brought Bibiano Fernández Osorio-Tafall, distinguished Spanish biologist, to Chile in 1949. Exiled in Mexico after the Spanish Civil War, Osorio-Tafall left his adopted home to head the regional office of the newly-created United Nations Food and Agricultural Organization (FAO) in Santiago (Pinar 2001). In doing so, he joined a new international cadre of civil servants dedicated to tackling what they believed to be the single most important issue facing humankind: world hunger. Osorio-Tafall was convinced that fisheries would be central to this endeavor. Yet he and his FAO colleagues were not the only ones who recognized the value of untapped ocean resources off the coast of western South America. Humanitarian desires to use the region's fishes to combat malnutrition through direct local consumption clashed with efforts by businessmen and policymakers, from both North and South, to produce fishmeal for animal feed. In the 1950s and 60s, these competing visions represented vastly different projects for the political economy of the emerging international capitalist system: whether the small schooling fishes that flourished in Peruvian and Chilean coastal waters would offer a solution to the problem of hunger in the developing world, or whether their industrialization represented an opportunity to consolidate new business empires based on the rich nutrient base of the Humboldt Current marine ecosystem.

In the aftermath of World War II, food shortages and commodity price swings greatly preoccupied political leaders in the North, who were anxious to maintain stability as well as to secure the United States' position as global superpower. For social-minded international civil servants like Osorio-Tafall, marine fisheries in the Southeast Pacific offered hope for improving the production and distribution of food, especially proteins, in developing countries. To industrialists on the U.S. West Coast, however, investing in Peruvian and Chilean fisheries was an entrepreneurial exercise aimed at transforming ocean resources into commercial capital by harvesting, refining, and selling them as concentrated proteins to the highest bidder. Observers reported an abundance of anchovies off the southern coast of California, but following the sardine collapse in the late 1940s and early 50s, the state prohibited the fishing of anchovies for fishmeal, while the processing plants and fishing boats of Monterey and San Francisco languished in port for lack of raw material. On the other hand, off western South America swam immense schools of *anchoveta*, sardines, and mackerel – ideal for fishmeal and oil production – as well as tuna that migrated along the Pacific coast. Meanwhile, facing waning local supplies of sardines and tuna, fishing firms in California sold or transferred defunct boats, equipment, and even entire processing plants to the expanding operations in Peru and Chile.

Some U.S. West Coast businessmen believed that fishmeal, whether for animal feed or as protein concentrates for human consumption, would be a highly lucrative investment. Indeed, as U.S. consumption of “white meats” climbed steadily during the post-World War II era (Horowitz 2006), specially-formulated feeds that incorporated fishmeal replaced the nutrients that free-range animals would otherwise obtain by foraging on open land. The proteins in fishmeal allowed chickens and pigs to grow in confined spaces, resulting in a faster time-to-market and increased weight – a property so poorly understood among researchers that they termed it the “unidentified growth factor” (Pensack, Bethke, and Kennard 1948). Beginning in the late 1950s, the explosion in fishmeal production using *anchoveta* and sardines caught off the coast of Peru and northern Chile drove down world prices of fishmeal. By the 1960s Peruvian fishmeal was a key input in the growing poultry and swine factory farms of the United States and Northern Europe. After 1962 fishmeal futures contracts were even being traded on the New York and London stock markets, allowing investors in the global North to speculate on the fluctuating populations of fish in the Southeast Pacific.

This paper examines why and how, amidst efforts to combat malnutrition both locally and globally, the post-World War II industrialization of Peruvian and Chilean fisheries focused ultimately on fishmeal production for animal feed. It presents a paradigmatic case of the entanglements of global, national, and local interests as societies transformed and exported nature in the form of a commodity that took on central importance to the global food industry. As scientists, policymakers, businessmen, and fishers worked through (and outside of) state and international institutions to defend their interests in Peru-Chile fisheries, new inequalities took shape linking global capital to local ecosystems and the people who depend on them. International technocratic visions of the potential of Humboldt Current fisheries resources to meet social needs clashed with local elites’ desires to use the fish to fuel local industrial development. Yet like many of the immigrants who worked in the fishing industry, the region’s wealthiest magnates – Luis Banchero Rossi in Peru and Anacleto Angelini in Chile – came from Italian backgrounds and built their fortunes on fisheries in their adopted Pacific homeland. Ultimately the extraction of resources for export and trade in global futures markets was more profitable than strategies encouraging food production for local consumption, as infrastructure and technology for preservation and marketing of fish products required significant investment. Rapid industrialization and periods of boom and bust characterized the post-World War II trajectories of Pacific coastal towns such as Chimbote, Peru, Talcahuano, and Iquique, Chile, whose fortunes rose and fell on the health of the marine ecosystem that supplied proteins for farmed animals across the globe.

An uneven geography linked the raw proteins of the Humboldt Current to food production in distant markets through the global industrial food chain: the availability of cheaper chickens, eggs, and pork chops at supermarkets depended on the commodification and systematic redistribution of nutrients from this marine ecosystem to livestock and fish farms supplying urban centers and other mass markets in the global North and East Asia. Fishmeal is thus an important but seldom examined factor in the political ecology of the global industrial food web, including the rise and consolidation of U.S. agribusiness giants such as Cargill and Ralston Purina during the 1960s and 70s. In Peru and Chile, the industry brought about the formation of new national elites. Efforts by the FAO and national governments to stimulate direct local consumption of fisheries resources, including programs to incorporate "fish protein concentrate" (FPC, or fish flour, versions of fishmeal suitable for human consumption) into foods for undernourished populations faltered in the face of rising demand for "white meats" such as chicken breasts and pork chops in the global North. But with an abundance of raw materials and few restrictions on harvest during the fishmeal boom (c. 1957-1972), industrialists in both Peru and Chile as well as the United States focused on short-term profitability, which favored the limited investment required to produce and export fishmeal for heavy – if risky – returns. Finally, the collapse of the Peruvian *anchoveta* in 1972 and political turmoil in Chile during the early 1970s ended immediate prospects for commercial production of fish flour or FPC for human consumption by 1973.

2. Modern Oceanographic Science in the "Pacific Fisheries Frontier", 1918-1964

In California the production of fishmeal from sardines became increasingly profitable in the years following World War I, when oversupply first encouraged their "reduction" for use in animal feeds and fertilizers. The North Pacific sardine fishery, once the largest on the U.S. West Coast, supplied the fabled canneries of Monterey, San Francisco, and Southern California through the end of World War II. Fish waste and whole fish not used in canning became meal, flour, oil, or fertilizer in reduction plants usually owned by the canneries themselves. With no restrictions on sardine extraction, production fast outpaced demand for canned sardines, and processing of whole fish into meal took off after 1918, effectively subsidizing the production of canned fish because depressed prices for the latter limited profits in available markets. On the other hand, canneries not attached to fishmeal plants could not compete (McEvoy 1986; Ueber and MacCall 2005).

California authorities opposed the industry's utilization of edible fish to produce fertilizer and animal fodder. The state enacted several pieces of legislation after 1919 strictly

limiting the reduction of whole fish to fishmeal (Messersmith 1969). Firms instead produced fishmeal from whole sardines on factory ships beyond the jurisdiction of California State Law, which extended to three nautical miles. From 1934 to 1946, the sardine industry boomed; in the 1936-37 season, fishermen brought in the largest single-species catch ever landed off the U.S. West Coast (Ueber and MacCall 2005). As much as four-fifths of the total California sardine harvest directly supplied fishmeal plants during the 1930s, making the commodity up to 20% cheaper than its closest competitor, processed meat scrap, and greatly improving the productivity of California poultry producers during the difficult economic climate of the Great Depression (McEvoy 1986). Fishmeal, not canned fish for human consumption, was the substance of the California sardine industry, and it also fueled the expansion of the state's chicken business through the transfer of marine proteins to the new industrial food chain.

The Peruvian and Chilean governments were also taking steps to develop industrial fisheries by the early 1940s, when some firms produced canned fish for export to U.S. markets. Many of the commercially-important pelagic fishes of the Eastern North Pacific – sardines, anchovy, mackerel, tuna, swordfish – are biologically similar or even indistinguishable from fish populations in the Humboldt Current. The Peruvian state-owned Guano Administration Company (Compañía Administradora de Guano, CAG) had been studying fishmeal production since the late 1930s, and had developed commercial ties with U.S. firms. Government officials and aspiring industrialists in Chile also preached zealously about the untapped potential of ocean resources (Lagos 1940). During the 1940s, the governments of both countries commissioned studies by the U.S. Department of Fish and Wildlife (USFW) in attempts to identify opportunities for industrial development. However, one observer noted resistance to the new enterprise among some Chileans: "Natural resources seem almost limitless", wrote U.S. Military Attaché Milton Hill (1945), "and the only real limitation is in the reluctance of Chilean capital to embark on new ventures".

The United States' military-technological imperative during World War II helped foster a novel vision of the Pacific Ocean among West Coast scientists who participated in wartime and early postwar research (Cushman 2004; Scheiber 1988). U.S. fisheries scientist and industry executive Wilbert Chapman heralded the "Pacific fisheries frontier" as the future of U.S. scientific and industrial expansion (Scheiber 1988; McEvoy 1986). He subsequently spent much of his career attempting to build coalitions among commercial fisheries, government, and science. By the late 1940s the California sardine harvest was in precipitous decline, following its peak harvest of 791,100 tons in 1936 (FAO 2010a). In Monterey, fishmeal production ceased in 1950, with the canneries operating only on fish trucked in from Southern California until

finally closing in 1957. When that industry went bust, state authorities set out to prevent the same fate from befalling the anchovy. In this context, Chapman, along with other prominent California scientists including Milner Schaefer, forged an inter-institutional, interdisciplinary oceanographic science that combined research in chemistry and physics with marine biology and data collection on upwelling and horizontal currents throughout the Pacific (Scheiber 1988). Perhaps presaging the rise of ecosystems-based fisheries management later in the twentieth century, this movement towards the integration of disciplines in ocean science and a broad biogeographical approach across the "Pacific fisheries frontier" had roots in the political-scientific realignment of the immediate postwar years.

Scientists of the "new oceanography" sought to understand the interactions of complex oceanic and climatic processes throughout the Northern and Southern Hemispheres, paving the way for the expansion of U.S. tuna and fishmeal interests in the coming decades. The University of California Scripps Institution of Oceanography (SIO) and the Hawaii-based Pacific Oceanic Fishery Investigations (POFI) were two key institutions in these early postwar research efforts. The collapse of the California sardine industry intensified the political-economic imperative to assess and develop the fisheries resources of the Pacific. One scientist involved in the USFW studies in Peru and Chile stated frankly to Chapman that he believed the California industry's survival would depend on fish off the west coast of Latin America (Lobell 1948). In fact, between 1937 and 1982, U.S. tuna producers were embroiled in what would become a protracted diplomatic conflict over access to migrating tuna (and until the 1960s, baitfish) off the coasts of Peru, Chile, and Ecuador.

North-South relations during the Cold War powerfully shaped the dynamics of "Big Science" and its patronage networks in the Pacific during the in 1950s and 60s, as U.S. technocrats sought to bring Latin American scientists into their sphere of influence in the context of large-scale projects to understand ocean-atmospheric interactions including El Niño (Cushman 2004). Many of the scientists who participated in the establishment, jointly with FAO funds, of nationally-based scientific research institutions in Peru and Chile – Instituto del Mar del Peru (IMARPE, 1960) and Instituto de Fomento Pesquero (IFOP, 1964) – had gained experience and training in the California Current or on FAO fisheries missions in other parts of the world (Ueber and MacCall 2005). South Americans also built successful careers by migrating north in pursuit of training, including Alejandro Bermejo, founder of the Peruvian fishing industry trade magazine *Pesca,* who studied with Schaefer in the United States. Bermejo and Schaefer, along with Gunnar Saetersdal, Ivo Tilic, and Bibiano Fernández Osorio-Tafall, and others,

were part of a transnational group of marine scientists who helped to build the world's industrial fisheries through their studies in emerging fishing nations during this era.

3. The FAO Mission and the Rise of National Fisheries in Chile and Peru

In 1943, U.S. President F. D. Roosevelt convened a meeting of delegates from 44 nations in Hot Springs, Virginia, to discuss the creation of a permanent institution "that would bring the new information in agriculture, science, and economics together in order to provide the world's people with adequate nutrition" (Staples 2006: 77). The formal establishment of the Food and Agricultural Organization (FAO) in 1945 was the result of decades-long lobbying efforts by scientists and technocrats from the United States and Europe who sought to wage "a war against want" amidst the new international order that was beginning to take shape.

But the FAO was also plagued by tensions among member countries, and its policies reflected a compromise between its stated goals and the political-economic agendas of member countries. One of the primary questions facing leaders of the new institution was whether it would work to stimulate agricultural production and stabilize prices as a regulatory agency, or simply collect and distribute information as an advisory body. While developing nations were eager for food aid and local industrial development, U.S. and U.K. leaders were reluctant to sponsor a large-scale restructuring of global commodity markets that could disadvantage producers at home. In the face of this ongoing tension, the organization's work – carried out mostly by appointed "expert" staff and mandated by biannual meetings of member nations – ultimately focused on technical assistance aimed at stimulating local food production rather than the international redistribution of resources from areas of agricultural surplus (Staples 2006).

Even if the institution itself lacked a strong social mandate, the individuals who carried out its mission often did not. The first director of the FAO Regional Office for Latin America, Bibiano Fernández Osorio-Tafall, lamented that there was little emphasis on fish as a protein source and that FAO should work to change this view among the population (Osorio-Tafall 1950b). He believed that promoting the development of regional fisheries for food production was one of the international agency's most important priorities. But without educational institutions for fisheries science in most South American nations, there was little locally-based research to support industrial development prior to the 1960s.

In Chile, which faced widespread food shortages in the early 1950s, President Gabriel González Videla solicited international technical assistance for recommendations and financing. FAO and the International Bank for Reconstruction and Development (IBRD) conducted an extensive study of agricultural production in 1951 (IBRD and FAO 1952). That year the FAO fisheries technical assistance program also began its work. When they arrived, FAO experts from northern European fishing nations were notably disappointed with the state of the industry. One biologist complained about a lack of cooperation and even distrust between the fishermen and local Chilean technicians, a deplorable ignorance about "modern" fishing gear and motors, a lack of "competition" in the marketplace, and tariff barriers preventing the importation of adequate equipment (Einarssen 1950). Another FAO technician noted that Chilean fishermen "work in very primitive and sad conditions" despite the abundance of Chilean seas (Dirección General de Pesca y Caza 1954). More troubling to the FAO's mission, however, was the reticence among industrialists in Peru and Chile to invest in the production of food fish. Such humanitarian priorities clashed with private industry's export-oriented agenda and need for credit. Rather than foreign-led "technical assistance" whose terms would be dictated by an international agency, Peruvian and Chilean industrialists hoped to establish and operate their own fishing enterprises.

FAO's early approach to fisheries focused more on issues of consumption and nutrition than on the significant structural impediments to marketing and distribution. One program involved a collaboration between a Danish fisheries economist, state authorities, and the Compañía Carbonífera e Industrial de Lota in organizing a "Fisheries Extension Program", promoting the sale and consumption of fish through print, radio, theater, and even local schools (Hernández-Ponce 1953). Another consisted of Comités Pesqueros Locales aimed at educating housewives in the purchasing and preparation of fish (Gomez 1954). The FAO claimed a 45% increase in fish consumption in one district of Santiago following these campaigns. In the mid-1950s, the high rates of fish consumption during Semana Santa every April required the government to mobilize the nation's entire fleet capacity from Iquique to Puerto Montt to supply Santiago for the holiday using airplanes.

The FAO also collaborated with the Chilean Nutrition Institute to develop recipes enriched with "fish flour" (also known as fish protein concentrate, or "FPC"), a type of fishmeal which has been processed using higher standards for raw material and sanitation practices, while also incorporating technologies to remove fishy odor and flavor. FAO-funded fellows from Chile studied "scientific baking" in the United States; the Chilean Nutrition Institute experimented with the use of fish flour in household recipes. In 1958, the United Nations Children's Fund (UNICEF) established a FPC plant

at Quintero on the central coast (Trivelli-Faranzolini 1954). But the UNICEF-Quintero project was plagued by administrative problems related to a lack of coordination among the various institutions involved (UNICEF, the Chilean National Health Service, and Swiss company ISESA, which also produced fishmeal at a separate plant in Quintero) and the lack of a centralized authority to control the product. The plant, which closed in 1965, produced only 15 tons of FPC which were used in trials in Chile and Peru. In all, international and national agencies carried out four separate projects to test or produce fish flour in Chile between 1953 and 1973, but none of them resulted in large-scale commercial production of FPC (Pariser et al. 1978).

4. North-South Currents during the Fishmeal Boom

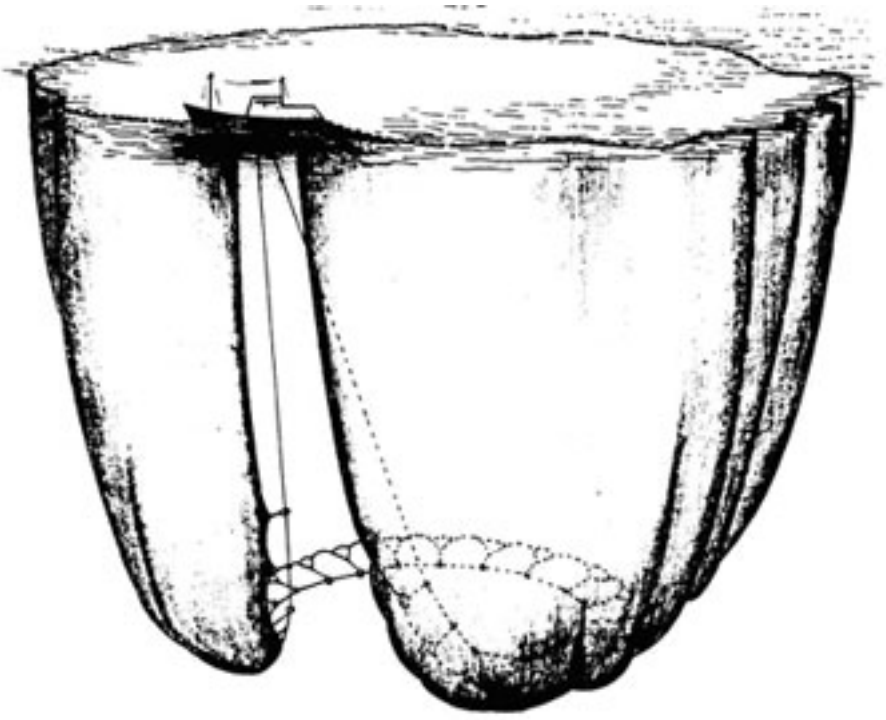
From 1950-1973, world fisheries harvests tripled while direct fish consumption remained stagnant (McEvoy 1986). The increased harvests, due in large part to Peruvian *anchoveta* landings, were used almost exclusively for the production of fishmeal for livestock feeds. Despite the rise of soymeal as a commodity competitive with fishmeal during the 1940s, Peruvian and Chilean fishmeal producers held a captive global market. By 1954, international demand for fishmeal was so strong that Chilean aviculturists complained that its exportation created a shortage for domestic feed producers, who that year would be forced to import a replacement product, a meat-based protein supplement imported from Argentina called *carnarina* (Hernández-Ponce 1953).

Scholars describe the 1950s as the era of the “designer chicken”, when U.S. breeders successfully experimented with hybridization to create broiler pedigrees that would be more marketable to consumer tastes; they also used genetics and nutritional science to manipulate the biological attributes of birds in order for them to grow bigger and faster (Boyd and Watts 1997; Boyd 2001; Bugos 1992). However, most studies on the rapid expansion of this industry in the United States have overlooked the importance of fishmeal. Particularly in the early postwar years, most poultry feeds relied on this commodity to provide the precisely-formulated nutrients that the birds required for growth (indeed, survival) on industrial farms, without the mobility and varied diet they would otherwise get by foraging seeds and insects. California poultry and swine producers remained “strongly loyal” to fishmeal, even when prices of competing commodities were low (McEvoy 1986: 199 note 59). Without it, California eggs and broilers became too expensive because the efficiency in production dropped, and they were unable to compete with those produced in the Midwest, where producers used soymeal and a synthetic amino acid to produce similar results (McEvoy 1986: 218 note 58). Nonetheless, despite decades of industry efforts to find substitutes for fishmeal

in animal diets, even by the twenty-first century the available synthetic, plant, or other animal protein feedstuffs proved unable to produce the same results (Miles and Jacob 1997; Palmer 2002).

Whereas early FAO programs focused on building up Chilean markets, California industrialists flocked to Peru during the 1950s and 60s to invest in fishmeal. The demise of the sardine fishery in the North had created a surplus of boats and equipment for fishmeal processing amidst an increased demand for fishmeal on industrial chicken and hog farms. While fisheries scientists and government agencies in California, Chile, and Peru forged international institutional relationships, the infusion of capital and technology from North to South generated an economic impulse for the industrialization of Southeast Pacific sardine and *anchoveta* fisheries (later also jack mackerel). Some California fishing firms and families sold purse seiners: fishing boats which capture schooling fish such as tuna, sardines, and anchovies by encircling and cinching the net to form a "purse" (as shown in Figure 1). Others sold entire fishmeal plants to Southeast Pacific entrepreneurs, while U.S. firms such as Cargill and Ralston Purina established subsidiaries in the region.

Figure 1: Purse Seine Net



Source: FAO 2001.

Peru imported mostly fishmeal and oil equipment, while California industrialists sold the newer and more expensive machinery to South Africa, another rising fishmeal

nation of the South. Southeast Pacific fishers adapted second-hand California seiners, called *bolicheras* in Peru and *goletas* in Chile, to local conditions for the *anchoveta* fishery (Ueber and MacCall 2005; see also print ads in *Pesca* 1960: passim). Local shipyards grew in importance as they produced new boats based on the "American" model, which proved well-suited to the relatively calm waters near the shore that were characteristic of Peru and Northern Chile. The equipment was easily adaptable and replicable due to the limited change in fishmeal technology and relatively light use of the machinery before the sardine crash.

The infusion of capital and expertise in fisheries following World War II came to the Southeast Pacific not only from the U.S. West Coast and the FAO but also from Spanish and Italian immigrants. In 1968, near the height of the fishmeal boom, 41.73% of Peruvian fishmeal was produced by industrialists classified in one study as "*recién llegados*", or recently arrived immigrants, while "national" concerns (which included the *recién llegados*) produced 61.60%. Spanish-born fishermen were reportedly the first to spot large schools of *anchoveta* off the coast of Peru (Abramovich 1973). Peruvian fishmeal magnate Luis Banchero Rossi was the son of Italian immigrants. Italian-born Anacleto Angelini immigrated to the Northern Chilean coast in 1948. Angelini started his career by investing in a once-failing fishmeal plant, Pesquera Eperva, later expanding from fisheries into forestry, copper, and petroleum. Angelini eventually became one of the most powerful figures in Chile, ranking number 119 on *Forbes* magazine's list of billionaires before his death in 2007 (Forbes.com 2007).

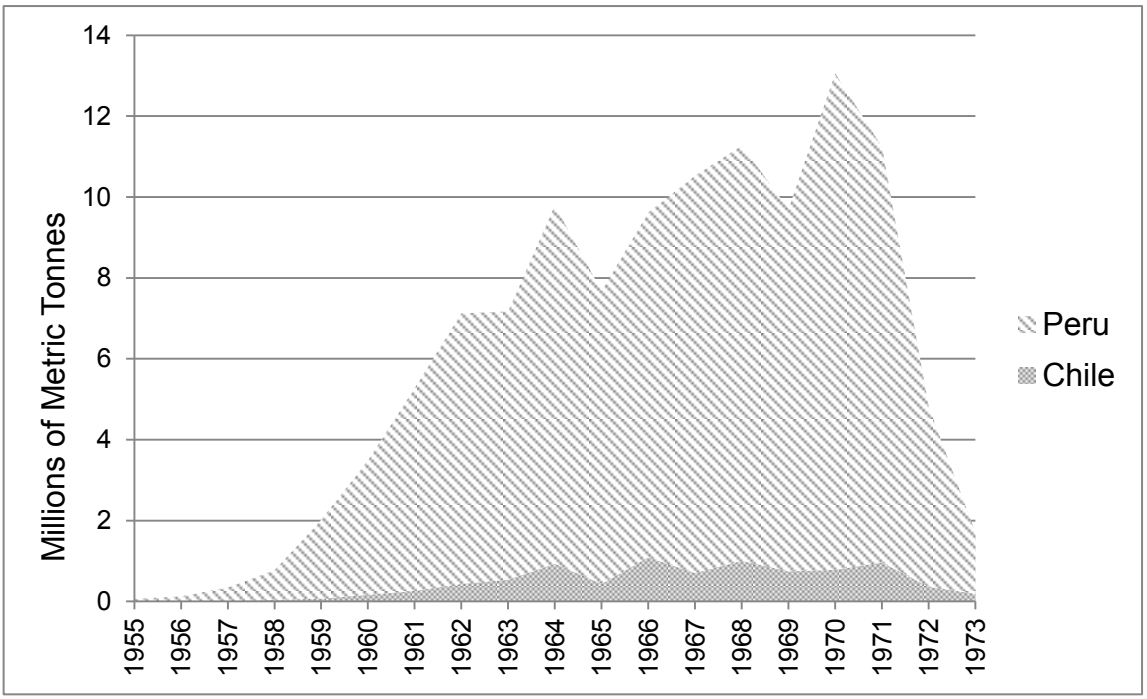
Northern capital was also fundamental to the foundation of Peruvian and Chilean industrial fisheries during the boom. Because poultry feed was the most significant cost in broiler production, it "became a source of competitive advantage" (Horowitz 2006). In 1960, Ralston Purina established fishmeal plants in Chimbote, Culebras, and Ilo, Peru. New York-based International Proteins Corporation, along with U.S. feed producers Star Kist, Cargill, Gold Kist, and Hamburg, Germany-based Gildemeister, were among the foreign-owned firms which accounted for 21.33% of the Peruvian fishmeal produced in 1968 (Abramovich 1973). U.S. pharmaceutical concern Pfizer and Company also installed a fishmeal plant in Iquique, Chile, and purchased a fleet of boats equipped with echo-sounding and spotter planes to supply it (Pensack, Bethke, and Kennard 1964; 1966).

U.S. feed producers engaged in backward integration in order to secure their supplies of fishmeal, the most effective known protein-source for chicken and hog feeds – and one of the most expensive and volatile inputs (Horowitz 2006; Boyd 2001; Bugos 1992; Abramovich 1973). By establishing operations in Peru and Chile, firms also reduced

their financial vulnerability to international price swings in case of fluctuating production. Like other agricultural commodities, fishmeal supplies relied on the productivity of natural ecosystems, and production throughout the year was not constant but rather concentrated in a few months when the target species were abundant. The Southeast Pacific Ocean climate undergoes strong fluctuations in atmospheric and oceanographic conditions every five to seven years, dramatically impacting fish reproduction and distribution. Depending on the seasonal production of other fishmeal producing countries as well as quantities in reserve, the price on the international market could at times drop below the cost of production; or it could skyrocket, driving up demand for other protein sources such as soymeal.

Peru was the epicenter of a spectacular boom in fishmeal made from whole *anchoveta* from 1957-1972 (see Figure 2). Abundant fish stocks located close to the coast, comparatively low capital requirements, and a lack of government regulation promised high profits, resulting in a meteoric rise in fishmeal production almost overnight. By 1960 Peru was the world's top producer of fishmeal, and by 1964 it was the leading fishing nation altogether, accounting for 40% of total global fish production (9 million tons) in terms of weight (Coull 1974; Lux 1971). In 1967, 70 to 80% of U.S. fishmeal imports for broiler feeds were from Peru (FAO 1967).

Figure 2: Landings of *Anchoveta (Engraulis Ringens)* in Chile and Peru during the First Boom Era



Source: Elaborated by the author with data obtained from the FAO global fisheries dataset using FishStatJ (FAO Fisheries and Aquaculture 2012).[1]

1 FAO data for the production of the fishmeal commodity is not available for the period prior to 1976;

Peru's dominance as the principal fishmeal producer on the global market empowered national entrepreneurial elites *vis-à-vis* their capital-rich Northern counterparts. Amidst a crisis in world fishmeal prices, in October 1960 producers convened in Paris and established a quota system in which Peru won 60% of the global total, 600,000 tons (*Pesca* 1960). Banchero Rossi, who represented Peru at the meeting, then formed the National Fishing Consortium, which controlled over 90% of the country's fishmeal production and monopolized its commercialization in the commodity markets (Banchero Rossi 1972). Rosemary Thorp and Geoffray Bertram (1978) argued that fishmeal was "the only really successful locally-controlled export sector of the period". Foreign penetration in the Peruvian industry occurred to a limited extent from 1962-1965, but by the end of the decade it stagnated and some firms had begun to withdraw. Fishmeal is distinct from other South American export commodities in that, despite the importance of foreign capital in the industry's early years, Peruvian and Chilean entrepreneurs have had a relatively greater proportion of ownership; magnates such as Banchero Rossi and Angelini represent the creation of non-traditional national elites through this industry. Not unlike the foreign firms that arrived on the coast during the boom, both men focused their entrepreneurial efforts overwhelmingly on fishmeal for export.

While the Peruvian *anchoveta* remained the global center of this new industry, a smaller stock of the tiny fish also swam off northern Chile, along with other species ideally suited to fishmeal production (mainly Spanish sardines and jack mackerel) due to their abundance and high oil content. Producers in the north of Chile hoped to emulate Peru's commercial success, and the Corporación de Fomento de la Producción (CORFO) actively promoted rapid development in the sector with credits and investments in infrastructure in Iquique, still suffering from economic depression following the collapse of international nitrate markets decades earlier. By the end of the 1960s, the South American fishmeal boom was in full swing, with Peruvian *anchoveta* harvests reaching an all-time high of over 13 million tons in 1971 (FAO 2010b). However, in 1972 excessive fishing pressure combined with the oceanographic impact of El Niño resulted in a devastating collapse of *anchoveta* stocks, sending the industry and global commodity markets into crisis and marking the end of this first boom phase in Southeast Pacific fisheries.

however, nearly all of the *anchoveta* catch was used for this purpose. Although this species is not (and was not) the only species used in fishmeal production, due to its prime importance, especially among Peruvian fishery landings, it serves as an emblematic – if singular – case that illustrates the dramatic nature of the rise of this global commodity during the postwar era.

5. Closing the "Protein Gap": Fish Protein Concentrate (FPC) in the 1960s

In the United States, during the Humboldt Current boom years of the 1960s, there were renewed calls to promote FPC and its use in undernourished populations. This discussion took place, however, without any reflection on the causes of previous failures in attempts to produce fish protein concentrate commercially. Promoters of FPC continued to call attention to its potential to bridge the so-called "protein gap" between populations in the developing world who had little access to proteins and consumers in industrialized countries, whose residents ate more meat than ever before. But after 1961 FPC became the subject of a protracted debate over the product's suitability for human consumption in the United States, which centered around a legal conflict between the U.S. Food and Drug Administration (FDA) and the Bureau of Commercial Fisheries over its approval for commercial use and domestic distribution. *Time* magazine depicted fish flour as a kind of superfood that not only "can restore balance to the diet at a daily cost of only half a cent per person", but "is virtually odorless and tasteless" and "blends well in soups, noodles, gravy, bread – even cookies and milk shakes" (*Time Magazine* 1967). One industry executive boasted about the possibilities of using FPC as an additive in foods as varied as Coca-Cola, spaghetti sauce, or tortillas (San Juan 1970). Unlike fishmeal for animal feeds, FPC was produced using higher quality standards for the raw material and special chemical processes designed to eliminate odor and flavor and to produce a fine powder that could be easily incorporated into foods. However, despite its technological and biological promise and considerable institutional support from both the U.S. government and the private sector, fish flour ultimately failed once again to meet commercial expectations.

In 1961 a panel of fishmeal experts recommended a joint Peru-Chile program as top priority for fish protein concentrate "action programs", some of which were already underway (FAO 1962a). U.S. and FAO experts traveled to Peru to evaluate the possibilities for the industry, though FAO did not end up building a plant (FAO 1962b). In an era when the fishmeal industry was booming, Peruvian policymakers were enthusiastic about producing FPC and industrialists looked to expand into new markets. Like the Chileans, they hoped to obtain, install, and operate the equipment necessary to produce it domestically (FAO 1962b). Peruvian government and industrialists built facilities and conducted clinical testing of fish flour. At least one FPC product was patented and licensed to Carlos Varrando Bruera in 1962-64, which was produced by a company called CIVSA and used in a bread enrichment program and a school breakfast program sponsored by the Ministry of Public Health. The Peruvian

firm Nicolini Hermanos, S.A., also experimented with using FPC in enriched noodles (Pariser et al. 1978).

At the same time, the U.S.-based VioBin Corporation, which produced and exported FPC in New Bedford, Massachusetts, from 1954-71, requested approval from the U.S. Food and Drug Administration (FDA) for distribution of the product in the domestic market (Ruthlow 1979). The FDA initially objected on the basis that fish flour made from whole fish is “filthy” and “adulterated” due to the use of whole fish and thus is not suitable for human consumption (Pariser et al. 1978). The FDA investigated the “wholesomeness” of FPC and its acceptability in U.S. markets through laboratory analyses, market research, media campaigns, and senate hearings, finally approving its production in 1967, with significant restrictions. Meanwhile, state agencies in Chile and Peru continued their work to develop the product for local populations – the original stated goal of the United Nations pilot projects during previous decades.

Following a protracted public debate, FDA approval for FPC in U.S. markets strategically came through just as the United States Agency for International Development (USAID) program “Food from the Sea for Undernourished People of the World” was preparing to get underway. AID selected Chile, along with Morocco and Korea, as the sites for three FPC feasibility studies (Pariser et al. 1978). The Chilean government took an active role in attempting to implement fish flour nutrition programs, but the USAID program aimed to develop overseas markets for FPC produced in the United States, not necessarily to stimulate local industry in the recipient country. After some confusion among Chilean officials who thought the U.S. was offering to install a pilot plant, they agreed to accept a 250-ton shipment of FPC produced by Alpine Marine Protein Industries (owner of the production rights to the VioBin process as of 1967). Of the original 1000 tons Alpine contracted with USAID to produce, only 172 tons were acceptable for shipment by USAID; 100 of those were allotted to Chile. Only 500 kg of FPC actually arrived at the Santiago airport. Worst of all, Chilean bioassays determined that the product was of poor quality – inferior even to what remained from the Quintero plant production (Pariser et al. 1978). By December 1969 USAID had frozen the feasibility study and terminated its contract with Alpine. USAID had also contracted General Oceanology, Inc., a Cambridge, Massachusetts-based consulting firm, to conduct a study of FPC beginning in 1968, which the firm completed without regard for previous work that had been done, finally presenting its report in June 1970. However, by that time, administrative shifts under Nixon, who terminated the Office of the War on Hunger and reduced the Food from the Sea Program, and political turmoil in Chile ended U.S. efforts to promote FPC there (Pariser et al. 1978).

Although FAO withdrew from the FPC program at the Quintero plant in 1968, the Chilean Fisheries Development Institute (IFOP) improved the FPC production process. IFOP scientists proposed to build a "multiple protein complex" for industrial production of a variety of fish-based products from a variety of marine sources, depending on supplies of raw material and prices on the international market (Pariser et al. 1978: 152-53). However, due to the turmoil and regime change in Chile during the early 1970s, these plans never came to fruition.

At the 1968 meeting of the United Nations Economic and Social Council, U.S. ambassador Arthur Goldschmidt distributed chocolate chip cookies enriched with fish flour to his colleagues. While the diplomats were "munching happily away", the *Los Angeles Times* reported, Goldschmidt presented them with a variety of products – pasta, cereals, "high-protein soft drinks resembling chocolate milk", "cola-type beverages", and baby food – designed by U.S. firms for sale and distribution in "protein-short areas" (*Los Angeles Times* 1968). But in the context of an institution that had been experimenting with FPC in the developing world for nearly two decades, the ambassador's overture seemed almost comically out-of-touch. By then, as USAID embarked on a final, unsuccessful attempt to promote FPC, business was losing interest in its potential to become a profitable enterprise. Yet Massachusetts Institute of Technology (MIT) scientists suggested that marketing and distribution of the product among protein-deficient populations with little purchasing power would be difficult, arguing that FPC was "economically not necessarily the solution for developing countries" (Pariser et al. 1978; Keil 1969). Sensing that the fishing bonanza in the Southeast Pacific was nearing its end, one U.S. fisheries executive had already begun to look elsewhere for new sources of raw material: "I've always felt that there must be two or three other 'Perus' around the world. [...] But our goal is a good business, not just a lot of fish" (Cohen 1969).

At least 40 countries made documented attempts to develop and commercially produce fish-based protein concentrates for human consumption from the 1930s to the 1970s, none of which had resulted in large-scale production (Pariser et al. 1978). Among the numerous institutions involved in the production trials of FPC, clashing goals and approaches, and a lack of communication due to inefficient and disconnected bureaucracies all contributed to the demise of this transnational project to use concentrated fish proteins to feed humans. In an era when international concern about hunger and food security was at a peak, the world's oceans became a new frontier for the science and technology of food production. But in order to operate the industry for the benefit of the hungry, state or intergovernmental subsidies needed to finance the costs because the product had an insufficient commercial market.

6. Conclusion

In the Kennedy-era vision of social policy, fish flour appeared to offer a simple technological solution to a situation that reflected vast structural inequalities in wealth and resource distribution at the global scale. By administering fish proteins to the poor, they hoped to avoid a social revolution while still sidestepping true social reform. As Pariser et al. (1978: 232) suggested, “high technology nutrition interventions” such as FPC – which failed to actually increase the protein/calorie supply for those at “nutritional risk” or increase their economic demand – “are to one degree or another only token palliatives offered by wealthy nations or local ruling elites in lieu of addressing the social and political factors underlying malnutrition”. The projects in Chile and Peru failed to establish any successful, continuously-producing commercial FPC plant.

Instead the two countries had by the 1960s become the world’s top producers of fishmeal. Requiring less capital investment in machinery and personnel, unrefrigerated anchovies and sardines processed into fishmeal with rudimentary technology and production process, fishmeal proved to be more profitable to most firms. Canneries used imported machinery and metals, more workers, and more stringent sanitation standards, while fishmeal required little human labor and the fish were often processed rotten, thus reducing costs on land. Fish were so abundant and cheap they were even labeled as “trash”; raw material supplies were thus readily available during production seasons.

The demise of the U.S. FPC program cleared the way for industrial production of fishmeal for export. Millions of tons of nutrients were extracted from the Humboldt Current marine ecosystem each year and shipped to distant markets in the service of industrial livestock production. North-South exchanges of technology and expertise leading to the fisheries’ industrialization were shaped by the U.S. Cold War political agenda and foreign economic interests. But the FPC projects failed because of a lack of interest among industrialists and the need for subsidization by the state or FAO, in the context of high global demand for animal feed commodities. The commercial success of FPC or the increase of any domestic fish consumption also required significant investment in local infrastructure and markets in order to distribute products to protein-poor provinces away from the coast. The post-World War II history of Humboldt Current fishmeal production demonstrates how local and regional inequalities become entangled with global economic processes as workers and industrialists transformed nature into commodities for trade, circulation, and consumption in international markets.

When the Peruvian *anchoveta* fishery collapsed in 1972, the crisis it produced was not primarily humanitarian but political-economic in nature, as Northern farmers faced a shortage of fishmeal and thus a rise in prices of chickens, eggs, and pigs. Rather than closing the "protein gap", the advances in fishing technology, nutrition science, and food processing capabilities that created this industry contributed primarily to the foundation of powerful business empires – both nationally, in Peru and Chile, and in the United States – that extracted and processed huge quantities of Southeast Pacific anchovies and sardines to feed industrially-farmed animals.

Marine capture fisheries in Peru and Chile today remain overwhelmingly focused on the production of fishmeal and oil, despite fluctuating supplies and competition on global markets from other protein commodities such as soymeal. Facing restricted supplies due to harvest quotas as well as pressure from conservationists to process the fish in smaller quantities for direct human consumption, some firms are beginning to shift their production strategies to include a higher proportion of these value-added items (see, for example, *The Economist* 2011). Yet while the Peruvian gastronomy industry is booming (Matta 2011; Lauer and Lauer 2006), grave problems of malnutrition persist, particularly among indigenous Andeans. In the inland freshwater lakes of southern Chile, on the other hand, the rapid expansion of salmon farming has been fueled by fish oil produced in the coastal cities of Talcahuano and Iquique and imported from Peru. The collapse of the industry due to virus outbreaks and its subsequent relocation to even more remote regions further south reminds us that, besides its dependence on wild-caught marine proteins for feed, natural resource-based "development" is ephemeral when consideration for ecological sustainability is not incorporated into the business plan (Soluri 2011; Deutsch et al. 2007). Recent studies highlight the central importance of forage fish in the marine ecosystem, especially for marine mammals in Peru (Pikitch et al. 2012). At the heart of the debate over the management of marine proteins derived from the *anchoveta*, sardines, and mackerel of the Humboldt Current are key questions of justice and sustainability that continue to demand urgent attention from scholars and policymakers, both locally and globally.

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