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The battle of the eyed egg: Critical junctures and the control of genes in Norwegian salmon farming

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ABSTRACT

In the pioneering period (1970s) of Norwegian salmon and trout aquaculture, the biological knowledge underlying this industry evolved in an institutional world of open science. Universities developed novel breeding techniques, and small grow out mom-and-pop farms implemented them. Eyed eggs were generic and standardized products, and traded at the lowest possible cost. As an eyed egg, the fry and in particular the eyes are visible through the membrane. The interplay between the regimes of open science and proprietary science has changed significantly in salmon aquaculture over the last two decades. One aspect of this change is that husbandry breeding has become more industrialized and subsequently more controlled by large, specialized and capital intensive breeding corporations. This paper explores this development from the perspectives of process-oriented institutional theory. We identify critical junctures in the coevolution of the breeding and grow-out sectors, and analyze how these junctures structure and change the direction of industrial and economic development. Ultimately, the generic, standardized and undervalued eyed eggs were subject to revaluation by the novel dominant international actors in the Atlantic salmon industry. We primarily draw data from interviews with core actors and informants at relevant universities, breeding companies and governmental agencies, as well as from white papers and other secondary material.

1. Introduction

A series of studies have emphasized how the organization of natural and social resources explains the success of Norwegian salmon aquaculture (Aarset, 1998; Didriksen, 1987; Hersoug, 2005; Jakobsen, 1996). The industry has benefitted greatly from a competent, motivated, and well-organized group of husbandry geneticists. Advancement in the breeding of salmon has been significant (Gjedrem, Robinson, Rye, 2012) but the impact of these scientists' contributions has been under-communicated.[2] Initially, the geneticists disseminated their knowledge openly and without compensation to the fish-farmers and the farmers took the gradual improvement in the productivity of farmed fish for granted. Recent developments in biotechnology have increased the geneticists' capacity to improve the productive traits of farmed Atlantic salmon (Dunham, Taylor, Rise, Liu, 2014; Gjedrem, Robinson, Rye, 2012) and the eyed eggs have become potent packages prepped with advanced biotechnology, wrapped up in a thin membrane and ready to be sent to the grow-out segment. In the process, scientific knowledge has become a high-priced, tradable commodity, highlighting issues related to the control and ownership of genetic material (Olesen, Myhr, Rosendal, 2011; Olesen, Rosendal, Rye, Tvedt, Bentsen, 2008; Rosendal, Olesen, Tvedt, 2013).

In this study, we analyze the industry-specific coevolution of grow-out farms and the organized breeding of salmonids in Norway. First, we investigate breeding and grow-out of salmon in a historical context, and identify critical junctures in the development of modern salmon farming. Second, we analyze the transformation of salmon breeding from its start as a publicly funded, research-driven applied breeding program to an enterprise dominated by private corporations and investors. In particular, we assess the impact of the expanding fields of biotechnology and genetics on this transformation. Third, we discuss the industrial implications of the production and application of new biotechnological knowledge. The production of scientific knowledge requires significant investments, and both public and private investors seek returns on their investments in the form of profits. Securing revenue from investments in biotechnology further requires protection of the investment patents, for example.

An examination of Norwegian salmon farming has significant value for other studies of the industrialization of aquaculture, as the development of salmon farming parallels other ventures in industrial aquaculture (Bostock, McAndrew, Richards, Jauncey, Telfer, Lorenzen, Little,

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[2] Personal communication with Per Olav Skjervold, independent consultant and aquaculture entrepreneur, October 26th 2011.

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Ross, Handisyde, Gatward, Corner, 2010). Characters common to many such ventures include delicate regulation issues over access to common aquatic areas, and pertinent market access issues impacted by the advances of biotechnology, followed by the demand for more complex intellectual property right regimes. Our empirical analysis concentrates on critical junctures understood as historical situations that allow for strategic action and change (Weir, 1992), using in-depth interviews with expert personnel. We selected informants based on their significant record in the history of Norwegian aquaculture. In addition, we systematically examined written material, such as reports, articles, and public policy (white papers). This triangulation of methods ensures a high level of precision in our analysis and presentation of the present rise of advanced biotechnology in fish farming. Our case study of Norwegian salmon farming is a thick description of the industry (Geertz, 1973; Redding, 2005), which ensures high external validity.

Salmon farming is one of Norway's major industries, with an on-the-dock value in 2013 of NOK 37.5 billion (Directorate of Fisheries, 2014). In 2011, 62% of the global production of farmed salmon originated in Norway (Norwegian Seafood Council, 2012) while direct employment in the Norwegian industry was 5526 employees (Directorate of Fisheries, 2014). Although production has risen considerably, the total number of licenses has remained somewhat above 900 for the last 15 years. Ownership of the grow-out sector, however, has been continuously concentrated since the removal of the ownership regulation 20 years ago. In 1990, the ten largest grow-out companies accounted for 8% of the licenses. By 2001, this number had increased to 46% (Aarset, Jakobsen, 2009) and to 65% in 2012 (Report to the Storting, 2012–13 no. 22). In 2012, the single largest grow-out company alone controlled 22% of the licenses.

In the present article, we focus on the transformation process from the 1960s through to 2013 within the Norwegian salmon-fishing industry. First, we develop a theoretical model consisting of four main internal and external explanatory factors of the transformation process. Next, we analyze the transformation process, and demonstrate the prevalence of critical junctures and their impact on the coevolution of farming and breeding. Our analysis also clarifies how the idiosyncratic development of industrialized Norwegian salmon aquaculture has resolved certain challenges and created new ones. Third, we integrate two major dimensions of our study: the evolution of the industry from a mom-and-pop enterprise to a modern seafood industry, and the merging of the historically separate sectors of breeding and grow-out in salmon farming. Finally, we explain how the role of breeding (and "eyed eggs") has been repositioned, subject to revaluation within salmon aquaculture.

2. Analytical framework

Institutional theory provides concepts that support our analysis of anomaly situations that typically arise when the structure of an institutional system loses explanatory power and falls apart. Prominent concepts are "creative destruction" in innovation theory (Schumpeter, 1934) "window of opportunity" in historical-institutional theory (Hall, Taylor, 1996; Thelen, 2003; Weir, 1992) and "external shock" in institutional theory (Scott, 1995). The anomaly allows new components to connect (Kuhn, 1962) at critical junctures (Collier, Collier, 1991). In our analysis, critical junctures are the arenas that provide gatekeepers with opportunities to decide which components can connect, and when. Three properties define critical junctures: 1) a claim that a significant change has occurred, 2) a claim that the change took place in a distinct way, and 3) a verified explanatory hypothesis about the consequences of the change (Collier, Collier, 1991).

In our empirical study, we focus on four explanatory factors. Two of them — evolving political regulation and merging industry structures (i.e. concentration of market power) — are internally driven processes. The other two — advancement of biotechnology and evolving regime of proprietary science — are processes driven by macro features, exogenous to the aquaculture sector, but with significant and growing impact on the development.

2.1. Evolving political regulation

Due to the position of the seafood sector in the Norwegian economy, the government took the role of an active partner in the national salmon farming endeavor. Several studies demonstrate how institutional engineering and political maneuvering were used to collect and organize public resources to build the salmon aquaculture industry in the 1970s and 1980s (Didriksen, 1987; Official Norwegian Reports, 1977 no. 39). In the 1980s, the industry experienced a steady growth. The government endorsed this development (Official Norwegian Reports, 1985 no. 22). A significant shift occurred in the 1990s, however, with the removal of the mandatory Fish-Farmers Sales Organization[3] (hereafter: Sales Organization) and the lifting of ownership regulation (Aarset, Jakobsen, 2009). These changes were in line with general changes in political institutions of the era, in favor of neo-liberal thought (Lindvall, Rothstein, 2006), opening the door for new structures of economic organization to emerge.

2.2. Emerging industry structures

Salmon farmers are economic actors and, as such, are in constant pursuit of returns on their investments. Fisheries economists conclude that the constant market pull sustained with continuous productivity growth are the main drivers of the growth of the Norwegian fish-farming sector (Asche, 2008; Tveterås, 1999). Emerging industry structures have coevolved with political institutions, and supported the farmers' search for costs to cut. Over time, significant changes have taken place in the structure of the industry. Asche et al. (2013) indicate that the productivity growth is now slowing down. New drivers for productivity are therefore called for.

2.3. Advancement of biotechnology

Since the turn of the millennium, the advancement of biotechnological methodologies has revolutionized breeding techniques in agriculture industries worldwide (Salgotra, Gupta, Stewart, 2014; Tribout, 2011). Access to these methodologies has also triggered industrial interest in the breeding of salmon. Breakthroughs in biotechnology and husbandry genetics have paved the way for novel developmental paths for food producers, such as more affordable and adapted products, improved quality, and more cost-efficient production. Biotechnological innovations will become increasingly consequential for the organization of knowledge production as well as for business models in aquaculture (Rosendal, Olesen, Tvedt, 2013).

2.4. Evolving regime of proprietary science

The relationship between government, academia, and industry are known as the triple helix, a concept borrowed from genetics, and launched to analyze the impact of these sectors of public life on economic development and innovation (Etzkowitz, Leydesdorff, 2000). Two different configurations of the triple helix confront each other in the application of biotechnology in aquaculture. One perspective, CUDOS,[4] emphasizes the sharing of information and ideas as the driver of the scientific progress (Merton, 1973; Rhoten, Powell, 2007; Schweik, 2007). Here, idea generation is a cooperative process involving exchange of experience, problems, and knowledge leading up to the distillation of new ideas. On the other hand, in the PLACE[5] perspective, a

[3] In Norwegian: Fiskeoppdretteres Salgslag AL.

[4] CUDOS, acronym for communalism, universalism, disinterestedness, originality, skepticism.

[5] PLACE, acronym for proprietary, local, authoritarian, commissioned, expert science.