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Summary

In the first part of the 20th century (ca 1900-1960), Swedish genetics developed into an important research field. The aim of this book is to follow and analyse the transformation of genetics from its origin within an agricultural context into its flowering as a fullgrown academic discipline.

When Mendel's work was rediscovered in 1900 it soon became adopted by plant breeders and evolutionary oriented botanists. Mendel's laws of inheritance were utilized to interpret the plant breeders' hybridization results, as well as the mechanism of evolution – a hotly disputed issue at the time. In Sweden, as in several other countries, Mendelism was established in close association with plant breeding. At the plant breeding station in Svalöf, a small village 20 km outside Lund, mendelism was introduced as a methodology during the first decade of the century by Herman Nilsson-Ehle (1873-1949). He was given a personal professorship in genetics at Lund University in 1917, mainly due to his success in improving some economically important crop varieties. This was the first professorship in genetics in Sweden and it was for long time the only one. As a professor Nilsson-Ehle continued to perform genetic research with close connections to plant breeding, but he also founded a strong research school of plant breeders and botanists interested in more general genetic and evolutionary issues. When he retired in 1938, his successor Arne Müntzing (1903-1984) – Nilsson-Ehle's former student – decided to break up the close association between plant breeding and genetics and establish genetics as a discipline within the academic context of Lund University. His aim was to turn genetics into a general, biological discipline and he wished to cooperate with other biological and medical scientists at the university. During his time as professor, Swedish genetics developed into a strong academic discipline. The institutionalisation of genetics can thus be described as a a two stage process. In the first of these stages genetics developed within an agricultural context infused with strong practical interests. This directed the research toward particular problems of great value for society and it increased the possibilities for the geneticists to obtain necessary resources. In the second stage the close cooperation between genetics and plant breeding had to be reconstructed in order to transform genetics into an autonomous discipline. To follow this process and the different interests behind the various policy shifts is a main theme of this thesis.

Thomas F. Gieryn's concept *boundary-work* is the key concept that I use in my analysis of the development of genetics. Boundary-work takes place when scientists want to delineate their science from other territories in a cultural map in order to legitimate their science. Gieryn focuses on the delineation of science from non-science, but the approach in this thesis is to use his concept more generally in the analysis of the establishment and transformation of the genetic discipline within the scientific field. As an emerging discipline genetics was constantly forced to construct its territory and borders and to defend its scientific authority. This was done in different arenas: in the agricultural

environment, in the academic system and in society at large. Within these different arenas different characteristics of genetics were emphasized, with the overall aim to increase its legitimacy and to obtain financial and institutional resources. Gieryn has emphasized that the boundaries of science are contextually variable and historically changing. They depend on historical experiences as well as local circumstances. This makes boundary-work a useful and relevant concept in the present study of how Swedish genetics was defined when research insterests and institutional affiliation changed over time.

The first chapter describes how mendelism was introduced as a method in plant breeding at Svalöf in the beginning of the 20th century. The Swedish Seed Association was founded in 1886 and the same year they started their breeding activities at Svalöf. It became the leading plant breeding station in Sweden and soon obtained a strong international reputation. In 1900 Nilsson-Ehle, who was educated as a botanist at Lund University, started to work at Svalöf, where he soon became interested in breeding methods based on mendelism (crosses). The director at Svalöf, Hjalmar Nilsson (1856-1925), advocated a different method based on the botanist Hugo de Vries' mutation theory. Nilsson-Ehle's and Hjalmar Nilsson's different opinions created a deep conflict between them, scientific as well as personal. In this conflict Nilsson-Ehle defended mendelism as a scientifically superior theory compared to the mutation theory. The reason was, according to Nilsson-Ehle, that mendelism was based on an experimental method. In 1909 he defended his dissertation where he showed how the variation in a quantitative character can be explained according to Mendelian laws, which was important both for the theoretical development of Mendelism and for practical breeding. The dissertation was internationally recognised and marked an important step in Nilsson-Ehle's career. He built a scientifical network of plant breeders and geneticists throughout Europe, and in Sweden he acquired a strong reputation as a successful plant breeder. Although Nilsson-Ehle was the most recognised Swedish mendelist at this time there were also several others. Together they founded the Mendelian Society in Lund, which became an important meeting-place for all interested in the new science of heredity.

In 1915 he obtained a professorship in botany at Lund University, although some in the appointment committee made clear that they did not consider genetics a significant part of the botanical discipline, a clear case of boundary-work from the botanists to protect their scientific interests. As a professor in botany Nilsson-Ehle continued to promote the practical interests of plant breeding, and soon it was publically suggested that he should be given a position from which he could continue his work as a plant breeder. It was considered a vital national interest to increase the national production of cereals, not least in time of war. The outcome of the debate was a personal professorship in genetics (*ärftlighetslära*) for Nilsson-Ehle. His new institute became located outside Lund in an association with the agricultural college at Alnarp, in order to create good conditions for the practical plant breeding experiments. The professorship was the first step in the establishment of genetics as a separate scientific discipline, and it demonstrated both the public confidence in Nilsson-Ehle and society's expectations of the new science of genetics.

The following chapter describes how Nilsson-Ehle developed his research programme in genetics, in which he emphasized the close connection between practical breeding and theoretical research. During Nilsson-Ehle's time as professor, genetics was viewed mainly as a practical science. He expanded its territory to include breeding of different kinds of economically significant organisms and emphasized the importance of genetics for the human population and the welfare of the nation. He was a successful entrepreneur and contributed to the founding of several new breeding institutes, which often were financed by the Wallenberg foundation, an important promoter of science in Sweden during the 20th century. With these institutes he tried to further legitimate genetic research and consolidate it as a discipline. During the interwar years he was also very active in the racial hygiene movement in Sweden. He was a mainline eugenicist with right wing political sympathies, and wanted to protect the population from degeneration and to preserve its genetical quality.

In 1925 he was made the director of the Swedish Seed Association after Hjalmar Nilsson and he was given permission by the official authorities to combine his professorship at the university with the directorship at Svalöf. As a result the Institute of Genetics was transfered to Svalöf and the connection between genetics and plant breeding became even stronger.

Much of the research at the Institute of Genetics was directed towards questions of importance for plant breeding. Several of Nilsson-Ehle's students wrote their dissertations on topics of this nature. But in parallel another strong research interest was developed, namely evolutionary genetics. In the third chapter we follow how one of his first students, Göte Turesson (1892-1970), founded a new research programme which he called gene ecology. Turesson wanted to use experimental methods to study genetic variation with the aim to explain the adaptation and distribution of plants in nature. Gene ecology became part of a broader research programme named experimental taxonomy, where experimental methods from the new specialities of genetics, cytology and ecology were used to study classical systematic questions. This was an international research area where Turesson was considered one of the pioneers. Several of the Swedish geneticists shared his interest in experimental taxonomy, and they wanted to transform classical Linnean systematics into an experimental science. They considered themselves as both geneticists and botanists, and some of them applied for professional positions in botany. The chapter analyses the development of the boundary-work that took place between the traditional botanists and the experimental geneticists/botanists. At stake was the definition and direction of systematics, but also the evolutionary geneticists' interest in creating a space within botany and increasing the possibilities for them to obtain academic positions. But, once again the botanists showed that they wanted to protect their own research interests. Henceforth the study of variation, speciation and evolution was relegated to genetics, where it often developed a more distinct cytological orientation.

In the next chapter we follow how Arne Müntzing was called on to succeed Nilsson-Ehle as professor in genetics and how Müntzing, with support from other theoretically interested geneticists, moved the Institute of Genetics from the plant breeding station at

Svalöf to Lund and the university. This was a "death-blow" to Nilsson-Ehles scientific model, with its close cooperation between theoretical developments and practical applications. Müntzing emphasized genetics as a general biological discipline and that its reseach questions should not be decided by the needs of plant breeding alone. This was necessary, according to Müntzing, if Swedish genetics should be able to retain its international position. Instead he wanted to cooperate with other biological and medical disciplines at the university. The Rockefeller Foundation supported the new direction of genetics at Lund University, which fitted well into its new research programme "Science of Man". The Chancellor of the university, also who was an active Social Democrat, supported Müntzing's plans as well. One can say that with Müntzing as professor, genetics re-defined its boundaries and changed its institutional context, in order to protect its autonomy and potential for future academic growth.

The fifth chapter analyses some issues of importance for the credibility of genetics in the period of the Second World War. The first deals with the discussion, on a national level, about eugenics. In Sweden, as in many other countries, mainline eugenics was at this time called into question by various scientists who rejected the race and class prejudices of the earlier racial hygiene movement. Although these "reform eugenicists" thought heredity was important, they emphasized environmental factors and social reforms instead of eugenic sterilization to reduce the "unfit" and "undesirable" in society. In their views mainline eugenics was based on flawed science. This conflict between mainline eugenics and reform eugenics was a struggle within the field of eugenics that also affected the geneticists and the intellectual legitimacy of their science with respect to the national public-health policy. At an international level, the crimes of the Nazi regime in German also raised several questions about the racism and anti-democratic values of the traditional racial hygiene movement. How the new generation of geneticists dealt with these question, during the war and in the postwar period, is discussed in this chapter. After the war the Lysenkoism of the Sovjet Union also led to a debate about science and politics, not least with respect to the International Congress of Genetics that was held in Stockholm in 1948.

In Chapter Six we return to the Institute of Genetics at Lund University to observe the institutionalisation of genetics in the postwar period, and how Müntzing tried to realize his vision of genetics as a general science, given the background of a general expansion of both research and higher education in Sweden. The research programme of the institute was broadened as Müntzing tried to include within it human genetics as well as zoological genetics, beside the continually strong tradition in plant genetics. Despite the dramatic break with Svalöf a decade earlier, the connection between theoretical genetics and practical breeding was preserved. The most successful expansion of the Institute of Genetics in Lund was, however, Albert Levan's (1905-1998) development of cancer chromosome research. This research was performed across different disciplinary boundaries, and demonstrated the kind of cooperation between genetics and other disciplines that Müntzing had strived for.

The last chapter deals with genetics in the public sphere during the postwar period. Geneticists had, from the beginning of the century, tried to demonstrate the great

societal value of their science, from plant breeding to eugenics. The social interests that could be linked to genetics greatly increased its credibility and legitimated the material and institutional resources given to it. Among Nilsson-Ehle's former students Åke Gustafsson (1908-1988) more than anyone else continued this tradition. Chapter Seven analyses two of his contributions to public debate: first his discussion about "the value of bad traits" where he questioned Sweden's sterilization policy, second his protest against nuclear weapons and his warning of an increased level of mutation. The first debate was linked to a more general discussion about biology and democracy which included moral as well as political dimensions. One main question was how the existence of genetic variation (which was necessary in evolution and good for the population, but at the same time implied harmful traits for individuals) could be combined with democratic values and equal rights for the individual. The second debate was linked to Gustafsson's research work with induced mutations in plant breeding. This became one of his main research interests during the postwar period, and he constructed a large national network of researchers within this field, thus extending – as did Levan with his cancer chromosome research – the boundaries of genetics.

The thesis concludes with a general discussion of the transformation of genetics from a practical to a theoretical science, which supports the idea of a heterogenous scientific landscape in Sweden during the first half of the 20th century, where research was performed in many different contexts and with widely varying aims.