

Kristine Bonnevie, Tine Tammes and Elisabeth Schiemann in Early Genetics: Emerging Chances for a University Career for Women

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Abstract. The beginning of the twentieth century saw the emergence of the discipline of genetics. It is striking how many female scientists were contributing to this new field at the time. At least three female pioneers succeeded in becoming professors: Kristine Bonnevie (Norway), Elisabeth Schiemann (Germany) and the Tine Tammes (The Netherlands). The question is which factors contributed to the success of these women's careers? At the time women were gaining access to university education it had become quite the norm for universities to be sites for teaching and research. They were still expanding: new laboratories were being built and new disciplines were being established. All three women benefited from the fact that genetics was considered a new field promising in terms of its utility to society; in the case of Tammes and Schiemann in agriculture and in the case of Bonnevie in eugenics. On the other hand, the field of genetics also benefited from the fact that these first female researchers were eager for the chance to work in science and wanted to make active contributions. They all worked and studied in environments which, although different from one another, were positive towards them, at least at the start. Having a patron was generally a prerequisite. Tammes profited from her teacher's contacts and status. Bonnevie made herself indispensable through her success as a teacher and eventually made her position so strong that she was no longer dependent on a single patron. The case of Schiemann adds something new; it shows the vulnerability of such dependency. Initially, Schiemann's teacher had to rely on the first generation of university women simply because he was unable to attract ambitious young men to his institute. In those early, uncertain years of the new discipline, male scientists tended to choose other, better established, and more prestigious disciplines. However, when genetics itself had become an established field, it also became more attractive to men. Our case studies also demonstrate that a new field at first relatively open to women closes its doors to them once it becomes established.

Keywords: Elisabeth Schiemann, history of genetics, history of women in science, Kristine Bonnevie, Mendelian genetics, patronage, Tine Tammes

If you had visited the northern Dutch city of Groningen in the 1880s, and happened to go into the confectionary shop owned by Beerend Tammes, you might well have seen a little girl seated behind the counter, immersed in a book.¹ In 1919 that same little girl, Tine Tammes, was appointed extraordinary professor of variability and heredity. She was the first person in the Netherlands to occupy a chair in genetics, and only the second female professor.

At the time, it was exceptional for a girl from a lower-middle class background to aspire to an academic career, no matter how intelligent and intellectually inquisitive she was. If we look at the life of Tine Tammes up to this point, we see that a complex of factors was of influence here. First, since 1899 the University of Groningen had been in a constant state of expansion. The new Botanical Laboratory, together with the botanical gardens, was a boon not only for teaching, but also for botanical genetic research. Second, the field of genetics, which then was beginning to take shape, was considered of vital importance to the agricultural institute that Groningen hoped to establish in the near future. And third, Groningen was the first Dutch university to admit women students, and had a liberal policy towards women academics. But the determining factor appears to have been the professor of botany, Jan Willem Moll, who did his utmost to give this inquiring and intelligent girl an academic career.

Tine Tammes (1871–1947) was not the only woman in the emerging field of genetics to be appointed a professor. The Norwegian Kristine Bonnevie (1872–1948) had already become professor in 1912, and the German Elisabeth Schiemann (1881–1972) would do so later, in 1930. In this article we discuss the emerging chances for a university career for women in early genetics, concentrating on these three cases. We focus on the discernable factors that worked out positively in Tammes' career: patronage, expanding universities with laboratories as research sites, women gaining access to higher education, and genetics as a new and promising field of investigation. First we introduce the complex of factors. Then we discuss the respective cases and finally we analyze the role of the factors in the three cases.

¹ Oral information acquired on November 29, 1996 from Professor de Jonge, a tenant at her home from 1945 to 1947, in 1996 living in Oegstgeest.

Female Students Gain Access to Expanding Universities

In the nineteenth century the university changed fundamentally.² Through the industrial revolution new scientific knowledge and expertise had become regarded as necessary. Universities, which for centuries had been schools of education wherein science played only a minor role, became the main centers of scientific research. Scientific education and scientific research came to be closely connected to universities, often by the establishment of institutes and laboratories devoted to specific and promising areas of investigation. The so-called model of the German university spread throughout Europe and the United States, although it varied, depending on local cultures and local circumstances. As a result, by the time women were asking for access to university education, at the end of the nineteenth century and the beginning of the twentieth century, it was normal that universities were sites for teaching and research. Universities were then still expanding: new laboratories were being built and new disciplines were being established.

That universities had become sites for scientific research had originally not benefited women with scientific interests and ambitions. Previously the home had mostly been the place for scientific investigation. Women could participate in this activity, often as helpers to fathers, brothers or husbands, but also as their co-researchers. In some cases they also became independent researchers, a phenomenon mainly restricted to the aristocratic class. As a result of the development of the research university, however, male researchers moved to the universities, which at this time were still closed to women. Consequently, speaking broadly, the activities of scientifically interested women came to a standstill. In addition, women from the newly developing middle class were even less in a position to be active in science. During the nineteenth century the separation between public and private life had become more strict for middle class women than it ever had been. The norm was that men participated in public life while women remained in the private sphere of the family.

However, with the revolutionary, democratic, liberation and emancipation movements of the late nineteenth and early twentieth centuries, female voices were demanding the right to vote, equal payment for work, legal equality as well as better and more opportunities for education. Young middle class women were no longer satisfied with staying at home after receiving some school education. Women were demanding the right to an education and to getting a job. These developments first

² For this section we relied on (Stamhuis, 2004).

took place in circles which respected learning as an important activity, but later on in other sections of the upcoming middle class as well. After 1850 secondary education opened up to women. Some schools, originally for boys, were opened to include female pupils and some separate secondary schools were established for girls. In addition, women were demanding access to education at the university level. At the end of the nineteenth and at the beginning of the twentieth century universities began opening their doors to the female sex, first as students, later also as members of staff and professors.

As stated above, during this period universities were still expanding by establishing new university disciplines. Usually such disciplines did not appeal to ambitious scientists because these new fields of knowledge did not yet have accepted places in the university structure. The fields were left unoccupied by the usual, dominant group of scientists. As a consequence, the division of power within such fields was not yet settled. People from groups originally unrepresented in academic circles found more opportunities in these fields than in established ones. These new disciplines in turn profited from the eagerness of these new participants to contribute to science. Obviously, when the first women at universities were seeking opportunities to contribute to science, relatively many entered the disciplines still in this early stage. Radioactivity, biochemistry, ecology and genetics were such fields at the beginning of the twentieth century.³

The New Discipline of Genetics

In this paper we concentrate on the emergence of genetics.⁴ Although thinking on heredity can be traced back to Aristotle, by the final decades of the nineteenth century various theories of heredity had been formulated, however without much empirical evidence. Charles Darwin's provisional hypothesis of pangenesis, August Weismann's germ plasm theory and, to a lesser degree, Hugo de Vries's intracellular pangenesis, belonged to the most well-known but also most heavily criticized theories. The last decade of the nineteenth century showed increasing experimental activity aimed at supporting theories of heredity. Physiological investigations were conducted to support theories in the field of developmental genetics, but it seemed difficult to find convincing experimental evidence. Therefore the focus often narrowed to

³ Richmond, 2006, pp. 565–566.

⁴ Harwood, 1993. Sapp, 2003.

transmission genetics. In order to study the transmission of characters, hybridization experiments were performed, although physiological observations were also made. The Mendelian laws were rediscovered in 1900. Thereafter, the applicability of the Mendelian laws was a topic of investigation: did these laws apply to other plants besides Mendel's beans and even to animal organisms as well? Moreover, could Mendelian laws also explain the heredity of continuous characters instead of only discrete characters? Continuous characters seemed to escape the Mendelian mold because their heredity was not in accordance with Mendel's law of dominance and recessiveness; it had long been common knowledge that their values blend in offspring. In addition, study of the relevant physiological processes remained part of the new research program that later became known as genetics. The processes of germ cell formation, of fertilization and the first stages of embryo development were especially popular topics. And with the publication of De Vries's *Mutationstheorie* in 1901 and 1903, genetics also included the study of mutations.

The new discipline of genetics was promising not only because of its challenging scientific questions, but also because of its promising utility. People expected that agriculture would profit from the results and genetic investigations were conducted in agricultural experimental stations. Moreover, in the course of the nineteenth century the eugenic movement came into existence. Its adherents supposed that genetics could help improve the human race. In summary, at the beginning of the twentieth century, genetics was a new, highly experimental discipline, with high expectations for utility. It had, however, not proven its potential. Dedicated researchers were necessary to develop and make the discipline a success.

Patronage

To understand the emerging chances of women, another factor has to be taken into account: patronage. This was not a new phenomenon. Before the nineteenth century, to have a career in science, patronage was normal and absolutely necessary.⁵ During the scientific revolution, scientists were usually situated at courts with the sovereign as their patron. The sovereign took care of fulfilling the material and scientific needs of the scientists. If no court was present, one nevertheless needed a high-ranking person to protect and take care of one's scientific and material

⁵ Abir-Am and Outram, 1987, especially the Introduction, 1-16, Abir-Am, 1996.

needs. In some cases one scientist served as patron of another. In the eighteenth century, a *Maecenas* was still necessary for a scientist to have the opportunity to do scientific investigations. Of course, there have always existed gentlemen-scientists of independent means who did not need patrons, but in the natural sciences such "Victorian scientists" had entirely disappeared by the time of our period of study, when the modern university was becoming firmly established.

Although, in the course of the nineteenth century, the ideology was beginning to take wider root that science was objective and that scientific merit should be the only criterion to play a role in the process of inclusion, old patterns remained in existence. When the modern university became established, the emphasis on patronage became less prevalent and scientific merit more important, but patronage remained necessary. For a career in science, a patron was absolutely indispensable. Even if one's family already belonged to the scientific community, having someone to pave your way into the scientific community made it easier to gain an independent position as a respected scientist. A patron was, of course, more important if one did not belong to the group from whom scientists usually originated. Thanks to a patron, some men originating from the lower-middle or lower classes successfully found acceptance in the academic world.

Patrons become superfluous when pupils become accepted as independent scientists. When pupils acquire sufficient academic standing, they continue developing themselves and no longer need a patron. Such people then belong to collegial networks, in which processes comparable to those between patron and pupil take place but now on an equal and reciprocal basis. When women first entered universities, their positions were usually insecure. One would expect patrons to be important to them. One doubts that, on their own, they would have been able to develop into independent scientists with well-functioning collegial networks.

National and local circumstances will, of course, play important roles in all the factors and processes discussed above. In some countries society is layered strictly; in other countries it is easy to cross class boundaries. Differences exist in societal attitudes to the role and purpose of women. Each country has its own form of feminism. The openness universities display to women reflects national characteristics. Differences exist with respect to the development of universities into modern research and teaching institutions. The traditional role of patronage was dissimilar in countries with and without a court culture. The discipline of genetics developed in various directions according to

local circumstances. The roles of agriculture and eugenics differed. Together, our cases from three European countries form an excellent opportunity to study how global factors received their distinct shapes dependent on local circumstances.

Tine Tammes

In 1871 Jantine or Tine Tammes was born in Groningen, in the north of The Netherlands, into a lower-middle class family.⁶ Her father Beerend Tammes was originally a worker at a confectionery, but by 1867 he had started a chocolate and confectionary factory. In 1883 Tammes entered the *Middelbare Meisjesschool* (MMS), a secondary school for girls. This school offered an education in keeping with the supposed nature of girls but was insufficient as a preparation for university. Until 1906, a girl needed special ministerial permission to attend a *gymnasium*, the official school which prepared pupils for university entrance. Only a limited number of girls, most of them belonging to the upper-middle classes, asked for and received this permission. After finishing secondary school, Tine Tammes took private lessons in mathematics, physics and chemistry and in 1890 she enrolled at the University of Groningen (Figure 1).

The Netherlands was relatively early to open its universities for women. Groningen University was the first. In 1871 Aletta Jacobs started to study medicine.⁷ Her sister Charlotte followed in 1877. Other universities also admitted women, but Groningen University seemed to have had the most open attitude towards this new group of students. When in 1890 Tammes entered Groningen University 11 women were studying there. She was allowed to attend lectures and practicals, but was not allowed to do the academic examinations. She was one of the pupils of the professor of botany, Jan Willem Moll (1851–1931). When she attended Moll's lectures, she probably met Moll's wife Anna C. Moll-Fruin, who enrolled in her husband's lectures in 1891 and 1892.⁸ In 1892 Tammes obtained her first teacher's certificate, in physics, chemistry and cosmography and in 1897 a second, in botany, zoology, mineralogy and geology. After some years teaching at the secondary school she attended as a pupil, she became Moll's assistant in 1897.

⁶ This section on Tine Tammes is discussed more extensively in (Stamhuis, 1995a). See also De Wilde, 1998, pp. 198–224; Westerdijk, 1937, 1948; Wijnaendts Francken-Dyserinck 1941; Schieman, 1949.

⁷ Jacobs, 1996; De Wilde, 1998, p. 85.

⁸ De Wilde, 1998, p. 123.



Figure 1. Tine Tammes. Source: University Museum Groningen.

Moll studied botany in Amsterdam and had gained his doctorate in plant physiology at Leiden University in 1876.⁹ As a student he met Hugo de Vries (1849–1935). A lasting friendship was established between the two young men. After having taught in Utrecht at two *Hogere Burgerscholen* (HBS), secondary schools for the lower-middle class, one of which was for girls, he was appointed as professor in botany at the University of Groningen in 1890, the same year that Tine Tammes enrolled. Moll undertook various initiatives important to the university. He ensured that the Botanical Laboratory was established, including a botanical garden opened in 1899. Moreover, he was one of the driving forces behind the attempts of the *Vereeniging voor Hooger Landbouwonderwijs* (Society for Higher Agricultural Education) in Groningen to establish an agricultural institute at the university.

Moll used his position, his influence, his friendship with De Vries and his organizational abilities to assist Tammes' scientific development. He

⁹ Van der Hoeven, 1934; Sch, 1934.

had noticed her talents early on. In 1896 Moll wrote about her to De Vries¹⁰: “She is indeed a very talented girl, who is devoted to science with all her heart.” In 1889, a year after her appointment as his assistant, Moll wrote to Hugo de Vries:¹¹ “And now something about Miss Tammes. Previously I have said to you that, sometime during her time as an assistant, I would like to second her to you to do some research under your guidance.” In 1889, in his book *Intracellulare Pangenesis*, De Vries published his theory of heredity.¹² After that he started an experimental research program in heredity and evolution. When Moll wrote to De Vries in 1898, the latter was fully occupied with the investigations that he would later report on in *Die Mutationstheorie*.¹³ Moll continued:¹⁴ “I know you don’t at all like having a lady as a visiting researcher, but I think it will turn out to be better than you expect; she is able to work independently very well and to choose her own direction. Therefore I am sure you will not be bothered by her.” Moll concluded this topic with the words:¹⁵ “I hope you will not reject this suggestion.” De Vries answered:¹⁶ “With respect to Miss Tammes I have serious objections about your proposal, but if this is what you want, I will of course agree. But beforehand I would like to know more about the expectations you both have of it. My opinion is that it will be most disappointing.” So thanks to the relationship between Moll and De Vries, Tammes could do research for a couple of months at De Vries’s laboratory. During this period Moll raised another topic, a job as an assistant at the Phytopathological Laboratory at Amsterdam.

¹⁰ “Zij is een inderdaad zeer begaafd meisje, dat zich met hart en ziel op de wetenschap toelegt.” Copy book 3, p. 259ff. Copy of the letter from Moll to De Vries, dd. 12 November 1896. Archive Moll, Library, State University, Groningen.

¹¹ “Dan nog iets over Mej. Tammes. Ik heb je vroeger wel eens gezegd, dat ik haar gaarne, gedurende haar assistentschap, eens bij je zou detacheeren, om onder je leiding een onderzoek te doen.” Copy book 3, p. 420ff. Copy of the letter from Moll to De Vries, dd. 9 November 1898. Archive Moll, Library, State University, Groningen.

¹² De Vries, 1889.

¹³ De Vries, 1901 and 1903. Stamhuis, 1995b, p. 12.

¹⁴ “Ik weet wel, dat je er niet zo heel erg op gesteld zijt, een dame voor onderzoek op bezoek te hebben, maar ik geloof dat je dit erg mee zal vallen; zij kan zeer goed op zichzelf werken en haar eigen weg gaan, zodat ik er zeker van ben, dat je geen last van haar zult hebben.”

¹⁵ “Ik hoop dus zeer, dat je dit verzoek niet zult afslaan.”

¹⁶ “Wat Mej. Tammes betreft heb ik wel erge bezwaren tegen uw voorstel, maar als ge het wilt, zal ik het natuurlijk doen. Maar gaarne zou ik toch vooraf meer weten, van wat zij (en gij) er zich van voorstelt. Het zal m.i. erg tegenvallen.” Correspondence from De Vries to Moll. Letter of 11 November 1898. Archive Moll, Library, State University, Groningen.

Moll had asked De Vries, who had been involved in the foundation of this institute, to use his influence to get Tammes appointed, but the latter wrote:¹⁷ “I fear that I can do as little for Miss Tammes as you can. I am no longer a member of the board of the Phytopathological Laboratory (...). The objection particularly that a lady cannot be required to inspect the fields in all weathers; I did it once when the weather was inclement, and it is dreadful work. (...) I have hopes that no one else can be found and that Miss Tammes will nevertheless be appointed.” That she was a woman played a decisive role in this job not being offered to her.¹⁸

Due to the fact that Tammes had not taken the official academic examinations she could not do her doctorate in The Netherlands and thus obtain an academic degree. By 1899 Moll had tried to make arrangements to get her a doctorate in another country. He also tried several times to find a job for her. In 1900, on Moll’s recommendation,¹⁹ amongst others, Tammes was offered a scholarship by the Buitenzorg Fund of the Royal Dutch Academy of Sciences to do research for four months in the Botanical Garden of Buitenzorg on Java in the Dutch East Indies. This scholarship was awarded once every two years to a budding biologist. A visit to the Dutch East Indies was often a first step in the career of such novices. Tammes, however, did not grasp either this opportunity or others to broaden her perspective, mainly for reasons of health and a sense of responsibility for her aging parents.²⁰

Her position as Moll’s assistant lasted until 1899. Thereafter she continued her scientific investigations at the new Botanical Laboratory. In 1903 she started investigating the characters of cultivated flax, *Linum usitatissimum*. Moll was once again the guiding force in this project. He took care that Tammes had the opportunity to do the important

¹⁷ “Ik vrees, dat ik voor Mej. Tammes al even weinig doen kan als gij. Ik ben geen lid meer van het bestuur van het Phytop. Laboratorium (...). Het bezwaar was vooral, dat men van een dame niet vergen kan in weer en wind de inspecties op de velden te houden; ik heb dit eenmaal in guur weer gedaan en ‘t is ellendig werk. (...) Ik heb de hoop dat men niemand anders zal kunnen vinden en dus Mej. Tammes toch wel zal aanstellen.” Correspondence from De Vries to Moll. Letter of 13 February 1899. Archive Moll, Library, State University, Groningen.

¹⁸ A commemorative article on the laboratory reads: “In 1899, when an assistant was needed, the possibility of asking Miss T. Tammes, a biologist from the University of Groningen, was considered but it was unthinkable that a woman could fulfill an advisory task,” Kerling, 1969, p.14.

¹⁹ This appears from a letter of 1905 from Moll to Went: Copy book 4, p. 129ff. Copy of the letter of Moll to Went, dd. 19 May 1905, Archive Moll, Library, State University, Groningen.

²⁰ Stamhuis, 1995a, pp. 502–503; De Wilde, 1998, pp. 201–203.

research that would be published in the Proceedings of the *Hollandsche Maatschappij van Wetenschappen* (Dutch Society of Sciences). In May 1907 her report, *Der Flachsstengel, eine statistisch-anatomische monographie*²¹ (The flax stalk, a statistical-anatomical monograph) appeared.

In the following years Moll was again of assistance. In November 1910 he recommended her for an honorary doctorate at the University of Groningen.²² Initially the case was deferred; it was unusual to award an honorary doctorate to a member of the own university, but in June 1911 it was put on the agenda again. Moll pleaded that Tammes be awarded an honorary doctorate in a letter to the Faculty of Mathematics and Physics, characterizing her investigations as “original” and “precise.” She had carried out physiological investigations, but “her main activity is in the field of experimental systematics, initially developed by Hugo de Vries.” And “among those who have done independent research building on De Vries’s work, her name has to be mentioned in the first and foremost place.”²³

At that time Tammes finished her important hybridization research. Moll was the first to refer to this work. In 1911 she published an article in which she discussed whether Mendel’s laws could also be valid for continuous characters. This 88-page article was entitled *Das Verhalten fluktuierend variierender Merkmale bei der Bastardierung* (The behavior of varying fluctuating characters in hybridization) and appeared in *Recueil des Travaux Botaniques Néerlandais*, the Journal of the Dutch Botanical Society.²⁴ Tine Tammes showed that the heredity of continuous characters could be explained by the so-called “multiple-factor hypothesis,” which meant that this heredity was also brought within the Mendelian framework. She was not the only one to argue this. Around 1910 several other articles were published supporting this case. However, Tammes’s contribution was the most convincing. Nonetheless its

²¹ Tammes, 1907.

²² Archive Senate and Faculties, State University Groningen, State Archive Groningen: Faculty of Mathematics and Physics, Inventory No. 623, minutes of the meeting of 11/11/1910.

²³ “Haar hoofdwerkzaamheid ligt op het door Hugo de Vries het eerst ontgonnen gebied der experimenteele systematiek.” “Onder hen die hier te lande, in aansluiting aan het werk van De Vries, zelfstandig onderzoek hebben geleverd, moet haar naam in de eerste en voornaamste plaats worden genoemd.” Archive Senate and Faculties, State University Groningen, State Archive Groningen: Faculty of Mathematics and Physics, Inventory No. 624. Minutes of the meeting held on 6/2/1918.

²⁴ Tammes, 1911.

importance was underestimated by her contemporaries as well as historians and therefore her case may be considered an example of the Matilda effect, the fact that scientific work by women is undervalued more often than similar work by men.²⁵

We may conclude from Moll's letter of recommendation that he was convinced that Tammes's investigations would be highly significant, and he used this argument to plead her cause. It was decided to propose to the Senate that Tammes be appointed an honorary doctor of the university.²⁶ In the meantime it had become clear how Moll intended to further promote Tammes' career. At an earlier meeting he had suggested appointing an extraordinary professor in the theory of heredity and variability, a proposal that was supported by the *Vereeniging voor Hooger Landbouwonderwijs* (Society for Higher Agricultural Education).²⁷ One of the primary reasons for such an appointment was that botany had become too broad a field for a single professor. One argument in favor of a chair in heredity was that the field was expanding rapidly and in the years to come would be of great significance for agriculture. No doubt he also referred to the existing plans for an agricultural institute. A third reason was the existence of a suitable candidate in the Botanical Laboratory, someone who was "qualified in all respects pertaining to this new subject." Someone who, moreover, would probably be willing to accept the "not particularly well-paid position of Extraordinary Professor." The curiosity of certain colleagues, intrigued to know who would be satisfied with the paltry salary attached to an extraordinary professorship, was soon satisfied. When Moll revealed that his candidate was Tine Tammes, it was immediately clear that there was no need to offer a single woman the salary of a full professor.

The faculty meeting accepted Moll's proposal and requested the Board of Governors of the university to propose that the government

²⁵ Rossiter, 1993; Stamhuis, 1995a, pp. 507–531.

²⁶ Archive Senate and Faculties, State University Groningen, State Archive Groningen: Faculty of Mathematics and Physics, inventory no. 366, minutes of the meeting of the Senate 5/7/1911.

²⁷ Addens, 1960: The "Vereeniging voor Hooger Landbouwonderwijs" (Society for Higher Agricultural Education) at Groningen was founded in 1906 and had been involved in the efforts to establish a Plant Improvement Station in Groningen. The aim of this society was to found an academic agricultural institute of education, connected to the University of Groningen.

make provision for an extraordinary professorship in the university budget.²⁸ This request was carried out.²⁹ However, the Minister of Internal Affairs was unwilling to accept the proposal. The Second Chamber of Parliament, which set the annual budget, did not agree with the Minister. In the ensuing debate some members were of the opinion that an urgent need for such a professorship existed, arguing in favor of its “great practical significance.”³⁰ The Minister of Internal Affairs answered that the “establishment of a new professorship did not seem urgent to him,”³¹ a noncommittal response without argument which resulted in no professor of genetics being appointed. If Tammes had been appointed then, not only would she have been the first professor of genetics, but the first female professor in The Netherlands as well.

In 1917 a new situation arose when Tammes’s fellow student J.C. Schoute was appointed as Moll’s successor. Schoute initiated a fresh campaign to secure her appointment. He succeeded in soliciting recommendation letters from the internationally most eminent experts in genetics at that time. The German Erwin Baur (1875–1933), the Swedish Hermann Nilsson-Ehle (1873–1949), the Danish Wilhelm Johannsen (1857–1927) and the English William Bateson (1861–1926) were all of the opinion that she was very suitable for this position, and they all spoke highly of her scientific abilities. Baur, to whom we will return when discussing Elisabeth Schiemann, wrote³² “Miss Tammes has shown by a long series of good and important works that she entirely masters the whole field and that above all she has the talent to carry out scientific investigations independently. In a similar case I would not hesitate for a second in proposing Miss Tammes for an extraordinary

²⁸ Archive Senate and Faculties, State University Groningen, State Archive Groningen: Faculty of Mathematics and Physics, inventory no. 624. Papers belonging to the minutes of the meeting of 6/2/1918.

²⁹ Archive Board of Governors State University Groningen, State Archive Groningen: inventory no. 529: Meeting of the Board of Governors 13/5/1911, no. 67.

³⁰ Handelingen van de Staten Generaal, 1911–1912. Bijlage A: Staatsbegroting 1912. Hoofdstuk V, Afd. IV, Art. 89. Voorloopig Verslag in de Tweede Kamer, p. 11.

³¹ Handelingen van de Staten Generaal, 1911–1912. Bijlage A: Staatsbegroting 1912. Hoofdstuk V, Afd. IV, Art. 89. Memorie van Antwoord, p. 38.

³² “Fräulein Tammes hat durch eine lange Reihe sehr guter und wichtiger Arbeiten gezeigt, dass sie das ganze Gebiet völlig beherrscht und dass sie vor allem das Zeug hat, selbständig wissenschaftlich zu forschen. Ich würde in einem ähnlichen Falle keinen Augenblick zögern, Fräulein Dr. Tammes für ein Extraordinariat vorzuschlagen, ihr Name hat überall im Ausland und vor allem auch hier in Deutschland den besten Klang.” Archive Senate and Faculties, State University Groningen, State Archive Groningen: Faculty of Mathematics and Physics, inventory no. 624, Papers belonging to the minutes of the meeting of 06.02.1918.

professorship; her reputation is of the highest in foreign countries, and especially here in Germany.” The recommendations were sent to the Minister of Education. This campaign resulted in her appointment in 1919 as extraordinary professor in variability and heredity. Thus Tammes became the first person in The Netherlands to occupy a chair in genetics. Moreover she became the second female professor in the country and the first at the University of Groningen. She would remain in that position until her retirement in 1937. Having grown up, she was still small. Medical doctors remember that she delivered her genetics lectures standing on a box.

Kristine Bonnevie

Born in Trondheim in 1872, Kristine Elisabeth Heuch Bonnevie was the third child of the school director Jacob Aall Bonnevie (1838–1904).³³ When Bonnevie was six, her mother died, her father remarried and had three more children. In 1880, father Bonnevie became a member of the National Assembly, and the family moved to Christiania (now Oslo).

Bonnevie became an important figure for the Norwegian educational system. Although he belonged to the conservative party, he was a reformist with respect to education. He was an important defender of the sciences. When it came to girls’ and women’s education, however, he was a good conservative. In 1880 he published a series of lectures under the title *Om den Kvindelige Uddannelse; Navnlig i de Høiere Samfunnsklasser* (On the education of women; especially those from the higher classes).³⁴ His main concern in these lectures was that all educational policy was directed towards the education of boys and young men, whereas the question of women’s education was to be left to the family. According to Bonnevie young girls were suited neither to the social setting of the school nor to its emotional and intellectual demands. He suggested instead that a handful of families should join together to enable the girls to study in private homes under the supervision of a mother – occasionally hiring teachers to take care of the more specialized aspects of their education (Figure 2).

We don’t know how he reacted when he understood that his daughters wanted to go to university. It is clear that their wish was not in accordance with his ideas on girls’ education. It is safe to say that he did not stop them. In 1888 Bonnevie’s older sister Honoria Bonnevie

³³ Føyn, 1950;

³⁴ Bonnevie, 1880.



Figure 2. Kristine Bonnevie in the laboratory of the biological station at Drøbak. Source: *Universitetshistorisk fotobase*, University of Oslo.

(1864–1928) enrolled and started to study for the teacher’s exams in mathematics and sciences.³⁵ Kristine followed in 1892. As female pupils were still not admitted to the public secondary schools, she was first a pupil at a private school which prepared young women for the “students’ exam,” which was then held at the university. Both her *gymnasium* testimony and her first pre-graduate exams (a common exam for all university students, which still exists) were passed with distinction, and she decided to study at the Faculty of Medicine, the faculty that attracted proportionally more female students.

Although women were allowed to attend university lectures from the very beginning of the Norwegian university (established in 1811), Norway was the last Scandinavian country to allow women to take university exams and degrees. In Sweden, they were permitted by 1872, and in Denmark from 1875, whereas Norwegian women were not permitted until 1884. It was first proposed that women should be allowed to take exams in medicine, as women were thought to be good at taking care of others’ needs. In 1882, the reaction of the medical faculty was unanimously negative, stating that women lacked the necessary abilities

³⁵ Kvindelige studenters jubilæumsskrift 1882–1907.

for both studying and practicing as physicians, that there would be more students than the faculty could teach, and that there were too few available positions for newly educated physicians.³⁶ However, when in 1884 the Liberal Party became majority in the National Assembly, a new proposition was accepted, stating that women should be allowed to study whatever they wanted.³⁷ Although there was some resistance, the fact that neighboring countries had allowed women to attend their universities might have weakened the opposition. However, this did not mean that in 1892, when Kristine Bonnevie entered the university, the proportion of women was sizable. Although there were more than at the University of Groningen at that time, fewer than 50 women had qualified for university entrance, and even fewer had graduated from the university.

Because zoology was part of the pre-clinical medical training, Bonnevie entered the modest Zoological Laboratory in 1893, then named the *Zootomisk Museum* (Zootomical Museum). The head of the laboratory was professor Georg Ossian Sars (1837–1927), a specialist in crustaceans. Sars was one of the first outspoken Darwinians at the university.³⁸ His lectures on natural history were immensely popular in the mid-1880s, but also controversial and contested by leading figures at the university. He was brother of the historian Ernst Sars (1835–1917), with whom he lived until his brother's death. His brother was a central ideologist in the Liberal Party, and the zoologist Sars was thus part of one of the most dynamic intellectual environments in Christiania, consisting of academics, artists and politicians. In these circles, John Stuart Mill with his *On the Subjection of Women* was well-known and found much sympathy. These people often gathered in the home of the Sars family, and it was said that Georg Ossian Sars used to sit in a neighboring room, working with his microscope while listening to the discussions and conversations.³⁹

When Bonnevie started to work at the Zoological Laboratory, the physician Johan Hjort (1869–1948) was the museum curator, a fairly comfortable job, which served especially promising academics as an in-between position. Hjort let Bonnevie work on materials collected during the Norwegian North Sea expedition of 15 years earlier. In the fall of 1894, she was offered a modest monthly salary to continue working on this material, which meant that she could quit her job as a teacher. The

³⁶ Referred to in *Proposition to the Storting* (National Assembly) no. 56 (1883).

³⁷ *Lov av 14. juni 1884*.

³⁸ Lie, 1984.

³⁹ Nordgård, Ole: *Michael og Ossian Sars*, 1918.

following year she published part of this work as co-author of an article with Hjort.⁴⁰ To her sister she wrote that “he is a nice boss to work for, pushing me along here and there, so I only have to do what he tells me to do.”⁴¹ In the same letter she describes herself as having luck, and that “the fathers of zoology have decided to push me further, and Alette says I’m a pet at the university.”⁴² The following year, in Hjort’s absence, Kristine Bonnevie stood in as curator, which meant that her monthly salary nearly tripled – in addition to the salary she received for her work on the material from the North Sea expedition. She wrote to her sister: “Actually, I should be Sars’s servant, but as he has absolutely no demands, I’m totally free to do and to come and go as I please.”⁴³

When Hjort returned to the laboratory and took back the work and salary of the curator, she was compensated economically by a doubling of her original salary for working on the North Sea material. In addition, she received grants almost annually to do field studies and collect materials along the Norwegian coastline. She continued to publish her findings, and by 1900, she had seven publications, ranging from foreign journals to popular lectures.⁴⁴ Three of them were part of the official report series on the materials of the North Sea expedition.

In 1898 she received a grant to go to Zürich to learn cytological techniques in the laboratory of professor of zoology Arnold Lang (1855–1914), which meant a reorientation of her scientific research. After her return Bonnevie sent a somewhat disillusioned letter to her sister: “All my prospects of positions or grants fail.” She wrote: “The

⁴⁰ Hjort og Bonnevie, 1895.

⁴¹ “Han er en hyggelig chef at arbeide under, for han puffer mig ivei baade hid og did, saa jeg bare har at gjøre, hva han siger.” NBH Bs 469 c:10a, letter from Kristine Bonnevie to Honoria Bjercknes, 04.11.1894.

⁴² “...zoologiens fædre har bestemt sig til at drive mig frem, og Alette siger, jeg er rent kjælebarn paa universitetet (Sars omtalte mine undersøgelser i en forelæsning forleden dag!), og jeg har ialfald for tiden indtryk af at jeg bor paa solsiden af livet; men det staar jo et sted i klassikerne, at naar guderne vil staffe rigtig strengt, saa sender de først store goder, for at smerterne kan føles endnu sterkere.” NBH Bs 469 c:10a, letter from Kristine Bonnevie to Honoria Bjercknes, 07.10.1894.

⁴³ “Jeg sidder nu i mit konservatorieværelse, hvor jeg forresten tilbringer næsten hele min dag, i en god skrivebordstol, – skrivebord med grønt klæde og alt hva jeg paa nogen maade har brug for, et mikroskoperbord, et tegnebord og et rodebord, Egentlig skulde jeg være Sars’s tjener, men da han er absolut fri for fordringer, er jeg fuldstændig min egen herre, kan komme og gaa naar jeg vil og gjøre hva jeg vil; jeg har en graaskjegget mand til at udføre, hva jeg finder paa, og til at gaa ærinder.” NBH Bs 469 c:10a, letter from Kristine Bonnevie to Honoria Bjercknes, 20.10.1895.

⁴⁴ See Føyn, 1950, Bibliografi on pp. 78–84.

fishery question is postponed, so Hjort sticks to his post.”⁴⁵ Hjort was probably no longer satisfied with his junior position at the university. During the summer a solution was reached on the fishery question; another job became available for Hjort and he was able to resign from his position as curator.

For Bonnevie, the curator vacancy might be a solution for her economic and scientific situation. She was, however, not the only interested person. There were four applicants but, according to Sars, who had to make a recommendation to the university senate, two of them were by far the best candidates. Bonnevie was one, Kristian Emil Schreiner (1874–1957) the other. In his report Sars compared these two candidates. Whereas Bonnevie had skipped the medical training and had therefore only the pre-graduate exam as her highest formal education, Schreiner had finished his medical education. Like Bonnevie, he had been employed at a laboratory during his studies, and had followed Hjort on a fisheries research journey. Both had received research grants to go abroad, for example to the laboratory of the professor of zoology Theodor Boveri (1862–1915) in Würzburg.⁴⁶ Sars stated that both were exceptionally gifted and talented, and each of them highly qualified for the position. To be able to choose between the two, the premises had to be more specific. Nowhere did Sars make it a question of formal education, in which Schreiner, with his medical degree, easily outstripped Bonnevie. His evaluation of the two candidates was based on his assessment of their zoological knowledge, experience in lecturing, practical knowledge of the institution, and reliability. In terms of zoological knowledge, he found that Schreiner was somewhat narrow and far too oriented towards histology, whereas Bonnevie represented breadth. Concerning the other relevant aspects, Sars knew nothing of Schreiner, whereas he was highly satisfied with the work that Bonnevie had done in Hjort’s absence. He put Bonnevie in pole position.

It is interesting that Sars ended his recommendation by addressing the fact that Bonnevie was a woman: “That the suggested applicant is a woman should not be an obstacle to her employment. Rather, it seems to me, the fact that it is still far more difficult for women than for men to

⁴⁵ Alle mine udsigter om poster og stipendier gaar i hundene; fiskerisagen blir udsat, derfor blir Hjort paa sin post, og samtlige professorer skal du og reise, saa ingen studerende kan faa stipendier. Amen.” NBH Bs 469 c:10a, letter from Kristine Bonnevie to Honoria Bjerknæs, 28.03.1900.

⁴⁶ RA UiO/SA, box 139 Ujnr. 510, application from Kristian Emil Schreiner, 26.09.1900.

reach an independent position in society, in itself urges us to make this choice.”⁴⁷ Sars took a political stand on the “woman issue.” The fact that he thought that he could use this argument gives the impression that the atmosphere towards women in the university senate, which had to give its consent, must have been rather liberal. Whether the issue was ever discussed in university senate is not recorded; in any event, the end result was that Bonnevie gained the position.

In the meantime Bonnevie had received another grant enabling her to go to Boveri in Würzburg.⁴⁸ Two months after her appointment on October 1st 1900, she went to that German university to continue her cytological training. Here she studied meiosis in three different *nematodes* and her findings made her continue to focus on one of them – the intestinal roundworm *Ascaris lumbricoides*.⁴⁹ Here she meant to identify an abnormal pattern in the production of sex cells, which deviated from an assumed universal process, and later she believed she had found the same deviating pattern in the gastropod or parasitic snail *Enteroxenos östergreni*. This interesting result would draw wide attention. In 1906 she sent in a doctoral paper based on these studies of germ cells.⁵⁰ She was successful in defending her thesis and became only the second woman to earn a doctorate from a Norwegian university. In October 1906 she left Christiania for a two-semester stay at the laboratory of the American Edmund Beecher Wilson (1856–1939) at Columbia, NY, and was also successful in convincing this well-known zoologist of the importance of her findings.

In June 1907 however, she received a copy of an article in which Schreiner, her previous competitor for the curator position, argued that her new view on the production of sex cells was invalid. She was worried about the possible consequences that Schreiner’s critique might have at home. “The man knows the field, you know,” she wrote to her sister, “and when the woman concerned is absent, it is easy to demolish her.”⁵¹ The actual number of people at home capable of taking a stance on the

⁴⁷ “At den foreslaaede Ansøger er en Dame, kan formentlig ikke være til noget Hinder for Ansættelsen. Tværtom synes deg mig, at man i den Omstændighed, at det endnu er adskilligt vanskeligere for Kvinder end for Mænd at naa frem til selvstændige stillinger i Samfundet, har en saameget større Opfordring til i nærværende Tilfelde at træffe det her foreslaaede Valg.” UiO/SA/JS. Jnr. 510 letter from Georg Ossian Sars to the university senate, 28.09.1900.

⁴⁸ RA UiO/SA, box 139 Ujnr. 510, application from Kristine Bonnevie, 26.09.1900.

⁴⁹ Bonnevie, 1901 and 1902.

⁵⁰ Bonnevie, 1906.

⁵¹ “Manden ved, hva sandhed er,” ved du, – og da idette tilfælde kvinden til og med er fraværende, er det let nok at tænke sig hende tilintetgjort.” NBH Bs 469 c:10a, letter from Kristine Bonnevie to Honoria Bjerknæs, 06.06.1907.

subject matter was, however, next to none, so even if Schreiner was actively spreading the word among colleagues, the entire episode must have seemed peripheral to most of them. Therefore whatever consequences she had feared, the critique presented by Schreiner does not seem to have affected her career in the sense of lost credibility at home, notwithstanding that her deviating interpretations of the production of sex cells were ultimately considered to be incorrect.

Bonnevie returned home and continued her work at the Zoological Laboratory; running courses in laboratory work, lecturing on general zoology and continuing the morphological studies in cytology. From 1908 to 1913 she published four more articles on cytological issues, all of them in *Archiv für Zellforschung*. Her local competition vanished as Kristian Schreiner was appointed professor in anatomy, and redirected his research interests towards physical anthropology.

When in 1901, just after her appointment as curator, Bonnevie returned from her visit to Würzburg, she wrote to the university senate asking for permission to run courses in the laboratory and lecture on zoology. “[I] have,” she wrote, “during my stay in Würzburg this year, in addition to my more specialized work, also attended lectures and participated in courses with the intention, after my return, to spend some time on the students’ zoological education.” The letter was co-signed by Sars, who gave his approval and recommendation.⁵² Although it was a professor’s duty and privilege to do the ordinary teaching, it seems that Sars was happy for Bonnevie to take over his teaching obligations. In the same year the university senate established a committee to consider whether junior academic staff should be generally more involved with teaching. This would mean that Bonnevie and others, who offered classes on a voluntary basis, would be offered a salary if the university senate found the teaching a necessary part of the course. Through this, Bonnevie’s teaching became part of the ordinary teaching from the fall of 1902, and she also participated in the examinations of pre-graduate students.⁵³

Zoology also included fieldtrips and excursions to the biological station at Drøbak. During the first decade of 1900 Bonnevie increased the number of these trips and excursions. Within a few years, it was clear that her courses in zoology were a success. She started to run two classes instead of the intended one, and even then some students had to

⁵² RA UiO/SA box 140 Ujnr. 313, letter from Kristine Bonnevie to university senate, 29.05.1901.

⁵³ RA UiO/SA box 142 Ujnr. 371, the Committee on use of junior staff in the teaching, June 1902.

be turned away. There is no doubt that the students experienced her teaching as a relief in contrast to the traditional lectures given by the two senior zoologists, Sars and Robert Collett (1842–1913). This may explain why, around 1910, Bonnevie was teaching an increasing part of the zoology curriculum. Bonnevie became indispensable with respect to the teaching in zoology. Obituaries and greetings related to jubilees about her suggest that she came to hold a very special position among students.

Around 1910 Bonnevie still held the post of curator, whereas her actual role was more like a professor's; she taught and examined the students, in practice she was directing the Zoological Laboratory, she held a doctorate and did research on an international level. She apparently found the situation in Christiania unreasonable and applied to the newly vacant and privately funded professorship in zoology in Bergen. When she became ranked number one for the job in Bergen, the students at home as well as the two aging professors, Collett and Sars, swung into action. As a result the university budget for the academic year 1912–1913 proposed that Bonnevie should be appointed extraordinary professor in zoology. A vacant chair was not necessary for an extraordinary professorship. The Proceedings of the National Assembly stated: "The so-called 'Zoological Laboratory', winning increasing affiliation from the students, and which is undoubtedly of critical importance to the study of zoology, is an institution whose emergence is entirely Miss Bonnevie's doing, and she has for several years led this institution with great ability and energy corresponding to the best modern models." Not surprisingly, it was Sars who formulated this statement. Similarly, professor in botany Haaken Hasberg Gran (1870–1955) stated that "Miss Bonnevie has turned the part of the zoological teaching given at the laboratory (...) into a central subject to students in science, who acquire observational skills at the laboratory, and has awoken their interest in biological problems in such a manner that it will be of the greatest importance to them for the rest of their lives."⁵⁴ Although there were some worries about the budgetary expense, this resulted in the necessary funding being granted, and in 1912 Bonnevie became the first female professor in Norway, initially as extraordinary professor and from 1919 as full professor.

Until then Bonnevie's investigations in heredity had concentrated on physiological investigations of the development of sex cells. Internationally, genetics was becoming more focused on transmission genetics, which was studied by means of comparing values of

⁵⁴ *Forhandlinger i det norske Storting*, 29.03.1912, p. 796.

characters of parents and offspring of hybridizations. When Bonnevie visited Boveri and Wilson, she came across this approach. In February 1914 Bonnevie applied for and received a research grant from one of the university research funds, planning to launch an extensive research project on human heredity. The main arguments in her application to the University Jubilee Fund were the increasing importance of Mendelian genetics in international biological research, its possible utility in society and the excellent conditions for doing such studies in rural Norway. In addition, in June 1915, Bonnevie joined four other professors in a request for annual budgetary funds for an institute for studies in heredity. The request was now supplemented with recommendations from health officials and physicians, who argued in favor of the future social utility of such studies. In the request it was again stressed that Norway was particularly well suited for studies in human heredity. The high degree of inbreeding gave a high frequency of interesting hereditary characteristics caused by recessive genetic factors.⁵⁵ The funds were granted, and Bonnevie became head in 1916. Actually, the funding of the new institute was little more than the annual funding of the work already being done by Bonnevie. There was, however, an important symbolic aspect to the founding of a university institute for studies in inheritance: it signified that the university experts on genetics were formally sanctioned as experts concerning questions on human heredity – and indirectly on questions of eugenics. Bonnevie declared her good will towards the concept of eugenics, but the only solid statement she ever made on the issue was that it should be based on a rigid scientific foundation. With the institute up and running under her direction, formal expertise in eugenics in Norway could now be found. After the establishment of the new institute, Bonnevie's professional life went on smoothly. She retired in 1936.

Elisabeth Schiemann

Elisabeth Schiemann was a decade younger than the other two. She was born in 1881, daughter of Theodor Schiemann, who in 1887 became professor in East European history at the University of Berlin. Her

⁵⁵ RA Zoologisk laboratorium, kopibok I, letter from Kristine Bonnevie, amongst others to a colleague requesting such an institution be taken into the university budget proposition, 09.06.1915.

father was known for his conservative political views.⁵⁶ After *Töchterschule* (daughter school), a secondary school for girls, she attended a teaching course (*Lehrerinnenseminar*) which she completed in 1899. Schiemann became a teacher of the lower groups of a secondary school for girls. In the Germany of the time teaching was one of the few professional opportunities open to women (Figure 3).

After a few years of teaching it was clear that she wanted to study in the sciences and in 1906, against the wishes of her father,⁵⁷ Schiemann became *Hospitantin* (attendant) in the natural sciences at the Friedrich-Wilhelm University in Berlin. She could not become a regular student, because women were not yet allowed. Compared to The Netherlands and Norway, the German states were very late in opening universities to women. In 1900 Baden was the first; Prussia, of which Berlin was then the capital, followed in 1908, although it was still forbidden for women to become *Habilitiert* (to qualify for the right to teach at university) and become a *Privatdozent* (private teacher).⁵⁸ No earlier than after the 1919 Revolution did women receive rights more or less equal to men. Only then could women officially hold positions at German universities, as staff members or private teachers, but not as full professors. Between 1918 and 1932 there would be 47 female private teachers at various universities, but since they were not salaried they played only a marginal role. Compared to other universities, the Friedrich-Wilhelm University had a sizable number of female staff and its Faculty of Sciences had more females than the Faculties of Humanities and Medicine. The reason was that research institutes of the Kaiser Wilhelm Society had more female staff than the university and they usually also taught at Friedrich-Wilhelm University. However, that was not yet the case when Schiemann entered university in 1906. She later recounted how, at the

⁵⁶ There are at least four more or less extensive discussions of the life and work of Elisabeth Schiemann with different focuses: Kuckuck, 1980; Lang, 1987; Lang, 1990 and Scheich, 2002. With the exception of language, the two biographies by Lang are (almost) similar. Scheich studied Schiemann's correspondence with Lise Meitner as that is preserved in the Meitner papers in the Churchill Archives in Cambridge. We are thankful to Scheich for having made interesting parts of these letters available through Scheich, 2002. More information can be found in Hertwig, 1956; Kuckuck, 1961; Linnert, 1972; Deichmann, 1997), especially pp. 232–236; Scheich, 1997; Vogt, 1999. Autobiographical or other papers written by Schiemann: Schiemann, 1935; Schiemann, 1949; Schiemann, 1959a; Schiemann, 1959b; Schiemann, 1960.

⁵⁷ Deichmann, 1997, p. 233.

⁵⁸ Vogt, 2004.



Figure 3. Elisabeth Schiemann. Source: Archive of the Max Planck Society, Berlin-Dahlem.

time, female students required the professors' consent to attend lectures.⁵⁹ She was regularly the only woman in class. Schiemann also observed that female students of natural sciences had no problems attending lectures and practicals, but female students of philology often faced resistance. In 1912 she earned her doctorate at the Friedrich-Wilhelm University with a 35-page paper in botanical genetics on mutations in *Aspergillus Niger van Tiegh*, supervised by Erwin Baur.⁶⁰

Baur became the most influential person in her professional life. He grew up in a pharmacy in a small village in the Black Forest, studied medicine, received his PhD in medicine in 1900 and on a botanical topic in 1903. Then he worked as an assistant at the Botanical Institute of the Berlin University and qualified as a teacher in 1904. In the period hereafter he became interested in the emerging field of genetics. In 1912 the first *Institut für Vererbungswissenschaft* (Institute for Heredity Research) in Germany was founded in Berlin as part of the

⁵⁹ Schiemann, 1960, p. 846.

⁶⁰ Schiemann, 1912.

Landwirtschaftliche Hochschule (Agricultural University). Baur became the director of the institute and professor of genetics at the university.

Contrary to many other German geneticists, Baur restricted himself to transmission genetics in the Mendelian framework, whereas many German colleagues were interested in developmental genetics.⁶¹ Later Schiemann would characterize Baur's scientific work as experimental. The fruit fly research of the Morgan school had become a model for Baur. "The dissertations of the Dahlem period are in the first place extracted from the question of the chromosome topography of *Antirrhinum*. With that choice Baur wanted to produce a botanical parallel to *Drosophila*."⁶² He was in 1907–1908 the first in the world to establish a journal dedicated exclusively to genetics: *Zeitschrift für inductive Abstammungs- und Vererbungslehre* (Journal of the Inductive Theory of Evolution and Heredity). In 1910 the English geneticist Bateson would follow with his *Journal of Genetics*.

Schiemann stressed that Baur wanted to put science at the service of the German people.⁶³ Germany was striving for economic self-sufficiency and genetics could play an important role in achieving this goal. The Institute of Plant Breeding Research, which Baur led from 1928, was apparently founded to serve the goal; it was organized around useful crops; there were departments of potato breeding, barley breeding, grape breeding, etc.⁶⁴ He was also sympathetic towards the new eugenic movement. For Baur, the synthesis of genetics and practical life in Germany could be found in breeding and in eugenics.⁶⁵

Baur drew Schiemann's attention to the significance of genetics. Plant breeding could be interpreted as artificial evolution and was therefore a way to study evolution. Baur also included mutations to study evolution and Schiemann investigated mutations for her dissertation. Schiemann became one of Baur's assistants. In the first period of this institute he attracted virtually only female assistants including, besides Schiemann, Luise von Graevenitz (1877–1921), Emmy Stein (1879–1954), Gerda von Ubisch (1882–1965) and Paula Hertwig (1889–1983).⁶⁶

⁶¹ Harwood, 1993, pp. 204–218, esp. p. 205.

⁶² "Die Dissertationen der Dahlemer Zeit sind zunächst der Frage der Chromosomentopographie von *Antirrhinum* entnommen. Baur wollte damit eine botanische Parallele zu *Drosophila* liefern," Schiemann, 1935, p. 83.

⁶³ Schiemann, 1935, pp. 96–97.

⁶⁴ Harwood, 1993, p. 205.

⁶⁵ Schiemann, 1935, p. 81.

⁶⁶ Deichman, 1997; Harwood, 1993, pp. 200–203, esp. footnote 13.

In 1915 the institute had to move to the neighborhood of Potsdam, and Schiemann took care of it while Baur was in the military service as a physician. In 1922–1923 the institute moved back to Berlin-Dahlem. In 1924 Schiemann qualified as a teacher and became *Privatdozent* (private teacher) at the Agricultural University in Berlin. She gave special lectures on seeds and on reproduction biology. She also prepared the student practicals. She carried out many fruitful investigations, including on the genetics of barley. A high point for her was the International Congress of Genetics in 1927 in Berlin, in which she played an important organizational role.

In 1927 the Kaiser Wilhelm Society decided to establish an institute for plant breeding research in Müncheberg/Mark, to the east of Berlin, under the directorship of Baur. According to Schiemann's biographers it was clear to all involved that at the new institute Schiemann would head an independent department for the history and emergence of cultivated plants. Schiemann later wrote that Baur had promised that to her.⁶⁷ This, however, did not happen. When her move was postponed several times and “newly appointed young scientists”⁶⁸ had already begun working in the new institute, it became clear that there was no place for her at the new institute. Friction developed between her and Baur and in 1930 the clash resulted in a splitting of ways. For Schiemann this event was a disaster, professionally as well as personally. Schiemann was not the only one not to accompany Baur to the new institute; Hans Nachtsheim (1890–1979) as well as all the other women scientists did not go either.⁶⁹

Several biographers of Schiemann discuss this disastrous event. Hermann Kuckuck (1903–1992), one of those “newly appointed young scientists,” pointed to the different attitudes of Baur and Schiemann towards the then younger generation.⁷⁰ Baur was a natural and charismatic leader with a democratic attitude who was very liberal towards the younger generation, whereas Schiemann demanded authority, based on her position and her attainments. She took good care of her colleagues and students, but thought in terms of hierarchical relationships. According to Kuckuck, Baur would have realized that the already existing conflicts between her and the younger generation would only have increased after the move. Schiemann's pupil Anton Lang also

⁶⁷ See the letter from Schiemann to Meitner 25–07–1943 cited in the discussion of her eventual directorship of the Kaiser Wilhelm Institute for Cultivated Plants.

⁶⁸ “neu engagierter jüngerer Wissenschaftler” Kuckuck, 1980, p. 522.

⁶⁹ Harwood, 1993, p. 206.

⁷⁰ Kuckuck, 1980, pp. 522–523.

stressed their different personalities. He wondered how Schiemann and Baur could have collaborated successfully for such a long time.⁷¹ Baur had a broad scientific view, he thought in great concepts, unhindered by inconvenient details, and he was a gifted speaker. Schiemann was just the opposite. She always paid great attention to detail; her lectures were dull and often uninteresting. The historian Elvira Scheich drew attention to structural factors. She stressed that to understand the different personalities, one must take into account that Baur belonged to the upcoming technocratic class while Schiemann was a member of the traditional élite. These classes had very different views about modern society, mass culture and democracy.⁷² The new upcoming class would turn out to be much more sensitive to National Socialism than the old civilized class. In this specific case Scheich added a personal factor, namely that in 1932, while Schiemann was expecting Baur to appoint her department head of the new institute in Müncheberg, Baur appointed Klaus von Rosenstiel to a position where the research was related to Schiemann's investigations. The same year this man, who had close ties to the upcoming Nazi regime, became his son-in-law.

In her obituary of Baur, Schiemann also commented upon this event, although indirectly. She vividly described the strong side of Baur, but did not hide what she thought of as his weaker side. She informs us that Baur was used to letting his assistants do their work very independently, but that he was always willing, as far as he was able, to deliver the necessary conditions.⁷³ Of Baur's character she said he had "a strong share of healthy Baden's democracy – and nevertheless he was a pronounced "Führer's personality."⁷⁴ With regard to the period after 1930 in Müncheberg she said: "Baur himself – that's the way his younger co-workers saw him – stood before them as a general who with a firm look first surveys the whole plan and then brings the troops into action at the right place."⁷⁵ He was so deeply immersed in his efforts that he did not realize the effect they could have on others. When at the beginning of his career he was looking for a suitable life goal, he was accused on several occasions of interfering in other people's fields, "probably not always

⁷¹ Lang, 1990, pp. 183–184.

⁷² Scheich, 1997, pp. 253–255, 260.

⁷³ Schiemann, 1935, p. 83.

⁷⁴ Baden is one of the German states with an apparent democratic tradition. "Ein starker Dosis gesunder badischer Demokratie war ihm eigen – und doch war er eine ausgesprochene Führernatur." Schiemann, 1935, p. 100.

⁷⁵ "Baur selbst – so sahen ihn seine jüngeren Mitarbeiter – stand unter ihnen wie ein feldherr, der mit sicherem Blick den ganzen Plan übersieht und die Truppen dann an geeigneter Stelle einsetzt." Schiemann, 1935, p. 97.

entirely unjustified,” according to Schiemann.⁷⁶ Schiemann undoubtedly referred to their clash when she described Baur as someone who “pushes people from one place to the other as if they were chessmen and drops them like dropping research projects when new and more important successors emerge.” She pointed to the consequences of Baur’s thoughtless behavior because that “has to result in conflicts, in which human being opposes human being.” And so “it could happen that after years of the most beautiful and successful joint work, the newly created Institute for Genetics Research at the Agricultural University, where Baur was entirely in a position to make his mark, became occupied by severe struggles on the sidelines and beneath the surface, often full of bitterness, which consumed resources on both sides that could have been used better.”⁷⁷

Nonetheless Schiemann became an extraordinary professor in 1931, which was a usual promotion because, having qualified for the right to teach at the Agricultural University five to seven years earlier, she had already become a private teacher.⁷⁸ Yet in 1931 she qualified for the second time, now at the Faculty of Natural Sciences of the more prestigious Friedrich-Wilhelm University in Berlin.

Schiemann remained at the Berlin-Dahlem Institute until 1931, when Hans Kappert, a young and little-known colleague, took over as director. She became an unpaid guest researcher at the Botanical Museum. Her research opportunities were restricted but did not disappear entirely. She was allocated space in the botanical garden and given a technical assistant.⁷⁹ Although she was not considered a gifted teacher, she enjoyed teaching and offered various courses related to her research interest.⁸⁰ She received some sorely needed financial compensation for these courses. From the time she left the institute until the end of the war, she had to fight a constant battle for the necessary research facilities, in particular where her experimental work was concerned.⁸¹ Her

⁷⁶ “Wohl nicht immer ganz mit Unrecht,” Schiemann, 1935, p. 63.

⁷⁷ “[M]usste in Konflikte führen, wenn Mensch gegen Mensch stand.” “So konnte es kommen, dass Jahre schönsten und erfolgreichsten gemeinsamen Arbeitens an dem neu geschaffenen Institut für Vererbungsforchung an der Landwirtschaftlichen Hochschule, dem Baur ganz seinen Stempel aufzudrücken vermochte, erfüllt sind und ausklingen mit nebenhergehenden und unter der Oberfläche verlaufenden schweren Kämpfen, die oft voll Bitterkeit waren und auf beiden Seiten Kräfte verbraucht haben, die besserer Verwendung wert waren.” Schiemann, 1935, p. 78.

⁷⁸ According to Deichmann, 1997, p. 233 “ausserplanmässigen.”

⁷⁹ Lang, 1990, pp. 184–185.

⁸⁰ Kuckuck, 1980, p. 525.

⁸¹ Kuckuck, 1961, p. 117.

research focus shifted from experimental work in genetics to investigations into the history of cultivated plants. This new work encompassed not only the field of genetics, but also aspects of archeology, history, ethnography and geography.

Schiemann was always very clear and open about her rejection of National Socialism and Fascism. It was therefore no surprise that, because of her political views, in September 1939 the university refused to change her extraordinary professorship into a new kind of extraordinary professorship and that in 1940 her right to teach was abolished.⁸² Fortunately Fritz von Wettstein (1895–1945), the director of the *Kaiser-Wilhelm Institut für Biologie*, where she regularly attended seminars with her students, helped her in getting a fellowship from the *Deutsche Forschungsgemeinschaft* (German Research Society), so that she could continue with her research.⁸³ In 1943 the Botanical Museum was destroyed by bombardment. Although Schiemann's office and her papers were saved, she could no longer work at this site. However, things soon took a positive turn. In the same year in Wien-Tuttenhof a *Kaiser-Wilhelm Institut für Kulturpflanzenforschung* (Kaiser-Wilhelm Institute for Research into Cultivated Plants) was founded under the directorship of Hans Stubbe (1902–1989), like Kuckuck one of the younger colleagues that Baur had included in the staff of the newly established Kaiser Wilhelm Institute in 1927. Schiemann was appointed director of the independent *Abteilung für Geschichte der Kulturpflanzen* (Department of the History of Cultivated Plants). She wrote to her friend Lise Meitner: "It is basically exactly what B had given to me in 1928, only to take it back one year later. Since then I have grown fifteen years older, and the times certainly have not made the job of building such a unit any easier."⁸⁴ She was very happy "that it ultimately became reality (...); a real happiness at my age, which I thankfully accept as such."⁸⁵

In 1943 Schiemann was happy with the proposal to become a *department* head. Probably she did not know that in the first plans of

⁸² Vogt, 1999, p. 125.

⁸³ Harwood, 1993, pp. 224, 225.

⁸⁴ Schiemann to Meitner, 25–07–1943. Meitner papers, cit. in Scheich, 2002, p. 270. "Es ist im Grunde genau das, was B. mir in 1928 in die Hand gelegt, um es mir ein Jahr später zu nehmen. Seitdem bin ich 15 Jahre älter geworden und die Zeiten haben solch eine Aufbauarbeit nicht gerade leichter gemacht."

⁸⁵ Schiemann to Meitner, 17–10–1943. Meitner papers, cit. in Scheich, 2002, p. 270. "[D]ass es doch noch Wirklichkeit wird (...) und ein wirkliches Glück in meinem Alter, das ich dankbar als solches hinnehme."

1939 she had been considered for the post of director of the *whole institute*.⁸⁶ In that year Stubbe wrote to Kuckuck “I would find it appropriate if at this institute Schiemann receives a directorship of a department; however I would find it unsuitable if she were given the directorship of the whole institute. (...) The institute has the task of organizing expeditions; therefore the leadership must be in the hands of a younger, decisive and energetic man, who is a good geneticist as well as a good systematist. As highly as I esteem Schiemann, I do not think she is able to direct this institute.” And “which male is ready to join the institute directed by Schiemann?”⁸⁷ Kuckuck agreed but added that one “has to admit, that Schiemann is the only truly all-round educated specialist in this field. (...) Therefore it would make sense to give her at least a sizeable part of the scientific leadership and the organization of the new institute.”⁸⁸ In 1944 Stubbe and a few others started work at the new Austrian site. Schiemann, however, did not join, because she was still in Berlin when the progress of war prevented further activities.

After the war, Stubbe soon rebuilt the institute, not in Wien-Tutenhof but in Gatersleben near Halle in East Germany, which, for unknown reasons, Schiemann did not join. She had her own department, which later developed into the independent *Forschungsstelle für Geschichte der Kulturpflanzen* (Research Institute for the History of Cultivated Plants). This institute was established in East Berlin as a part of the *Kaiser-Wilhelm Gesellschaft*. In 1946 she was ultimately appointed extraordinary professor at the Humboldt University.⁸⁹ Her

⁸⁶ Scheich, 2002, p. 269.

⁸⁷ Stubbe to Kuckuck, 10–07–1939, cit. in Scheich, 2002, p. 269. “Ich würde es für sehr angebracht halten, wenn Schiemann an diesem Institut eine Abteilungsleiterstelle bekäme, ich hielte es aber für verfehlt, wenn man ihr die Leitung übertrüge. (...) Das Institut habe die Aufgabe Expeditionen durchzuführen, die Leitung müsse daher in den Händen eines jüngeren tatkräftigen und energischen Mannes liegen, der sowohl ein guter genetiker als auch ein guter Systematiker ist. So hoch ich Schiemann schätze, so wenig scheint sie mir zur Leitung dieses Instituts befähigt.” “[D]enn welcher Mann würde sich dem Institut unter Schiemann’s Leitung einfügen?”

⁸⁸ Kuckuck to Stubbe, 04–08–1939, cit. in Scheich, 2002, pp. 269–270. “[W]ohl zugeben, dass Schiemann die einzige wirklich vielseitig durchgebildete Spezialistin auf diesem Gebiet ist. (...). Es wäre daher wohl zweckmässig, ihr zu wenigstens bei der wissenschaftlichen Leitung und Ausrichtung des neuen Instituts einen massgebenden Einfluss einzuräumen.”

⁸⁹ Kuckuck, 1980, p. 519: “Professor mit vollem Lehrauftrag” It is not clear if she became full professor or extraordinary professor. From Kuckuck (1980) one gets the impression that she became a full professor, but that seems in contradiction with her comment on her appointment in the letter to Meitner (see the following footnote).

comment to Lise Meitner was: “Yet women are still not eligible for full professorships.”⁹⁰ At that time Stubbe and Kuckuck both had already become full professors in Halle, where Paula Hertwig was appointed extraordinary professor. She commented on Hertwig’s appointment, “P.H. should have *long since* been appointed full professor. For women it has become so difficult to hold one’s ground, after 1918 and many other times.”⁹¹

The period after the establishment of her institute would be a quiet one. In 1956 at the age of seventy-five she retired and her institute was abolished. Her pupil Anton Lang commented in 1987 that “one cannot help regretting that this institution, unique in the entire world and in its budgetary requirements much more moderate than today’s institutions for experimental biology, could not have continued in some form. However, one may ask whether among Schiemann’s young co-workers or anywhere else somebody with her experience and vision for such a task could have been found.”⁹² It will have been a disappointment for her that the institute dedicated to the theme she had explored for many years was abruptly terminated.

Secondary Education and the Attitude of the Parents

Before we analyze how the positive factors mentioned in the three careers discussed above led in three different ways to professorships, we draw attention to the negative factors we encountered that also played a role. Remarkably, in all three cases the parents’ attitude towards academic education for their daughters and, related to that attitude, their choice of secondary school, was not the best. Tammes’s family was not intellectual. We do not know what her parents thought of having a daughter with university ambitions, but they probably did not encourage her. That she did not attend *gymnasium*, the official preparatory school for the university, is not astonishing in her situation. The choice of MMS, the secondary school for girls, was already rather unusual in her milieu. Evidently her parents did not refuse their intelligent and inquisitive daughter the opportunity to develop her intellectual abilities,

⁹⁰ Schiemann to Meitner 02–11–1946. Meitner papers. “Ordinariate kommen wohl auch weiterhin für Frauen nicht in Betracht.” Cit. in Scheich, 2002, p. 278.

⁹¹ 02–11–1946. “P.H. hätte ja *längst* selbst ein Ordinariat haben müssen. Es wird aber für die Frauen so schwer sich zu behaupten, wie nach 1918 und zu mancher andern Zeit.” Cit. in Scheich, 2002, p. 278.

⁹² Lang, 1987, p.27.

although it seems like they did not intend sending her to university. Unlike the family of Tine Tammes, the families of both Kristine Bonnevie and Elisabeth Schiemann were from the higher, intellectual class. Their backgrounds may ultimately have helped them to be accepted in academic circles. However, although Bonnevie's father believed that women needed an education, he did not consider university an appropriate place for women. Fortunately for Kristine, her older sister Honoria had preceded her. She followed her sister in attending the private school that prepared girls for the students' exam. Elisabeth Schiemann's father was also against university education for women. Schiemann went to a *Töchterschule* (daughter's school), which did not prepare pupils for university. The attitude of her father may have been the reason that she first trained as a teacher. All three followed indirect routes to university that took far longer than the direct route. Nonetheless all three were successful in overcoming this hindrance. They were determined to get the academic education that, luckily for them, had just recently become possible for women.

Attitude Towards Female Scientists at Universities and in Society at Large

What did these women meet on enrolling at university? At the time they arrived, educational and career opportunities for women were in the process of improving, but were not yet comparable to men's. Tammes, Bonnevie and Schiemann were each among the first female students at their respective institutions. They started off with the experience of belonging to the small minority of women in male-dominated environments.

In terms of the three distinct cases: Dutch universities opened up comparatively early for women, and the university that Tammes attended was the most liberal in the country. From the story of her career we may conclude that this university was always willing to cooperate to let her career run smoothly. However, it does not mean this attitude was also found elsewhere in The Netherlands. Support for this statement can be found in our paper. For example, De Vries did not seem very open-minded towards having a female visitor at his lab. Moreover, Tammes lost the chance of a job at the phytopathological laboratory, and subsequently the Minister of Education blocked the procedure to make her a professor for a long time. The overall impression is that Dutch society at large was not as liberal for female scientists as the University of Groningen.

The Bonnevie case gives the impression of an open-minded attitude in Norway towards female scientists not only at the university, but in the larger community as well. We must, however, be careful drawing this conclusion. In 1882 the Faculty of Medicine still barred its doors to women students. The eugenic movement, with its opinion of women as bearers of ideal children, would gain strength in Norway. It would be better to say that at the university and in intellectual circles in Christiania it seems like the attitude towards female academics was positive and that Bonnevie profited from that.⁹³

As for the Schiemann case: in the whole of Germany the position of women scholars was difficult. The generally negative attitude was reflected in universities. Schiemann was lucky in that the university she attended was the most liberal towards women, and its science departments were the most sympathetic. After her time as a student, she became a member of the institute directed by Baur, where she was in the company of other female investigators. Baur must have been glad that these women wanted to work in his institute and won't have shown a negative attitude. His place was, so to say, screened from society at large with respect to the prevalent attitude towards academic women. However, through Baur's decision not to take Schiemann or any other female scientist with him to the new laboratory, Schiemann will have fully experienced the tough attitude of the German society. In 1931 she became extraordinary professor and was offered a place in the Botanical Museum. It seems that happened just in time, because after 1933, when the Nazis came to power, the position of female scientists deteriorated dramatically. It is improbable that she would have been able to find a workplace then. During the Nazi period she lost her extraordinary professorship and her right to teach. After the war the situation of female scientists improved in East Germany and in 1950 she received an extraordinary professorship again. For all three women it can be said that during an important stage of their university career, the organization to which they belonged displayed an open attitude towards women scientists. That attitude was more positive than could be expected of the opinions in the wider context. For that period of time, they lived in a relatively safe haven.

⁹³ In a more extensive biography of Bonnevie we intend to discuss the view on female scientists from a eugenic perspective as that existed in Norway at that time.

The Expansion of Universities and the Emergence of Genetics

We have noted the expansion of universities into research sites. That the process of growth and development was especially strong in the new field of genetics was also clearly discernable. The promising utility of genetics was always used as a reason to establish and to expand this new discipline. Tammes profited from the new laboratory established by Moll. Because genetics was a new field, she was the candidate to become professor in genetics. No others were available because the position was then unattractive to established male scientists. But that had changed by the time Tammes retired in 1937. Thanks to her work, genetics had become a respected discipline at the University of Groningen. Her male successor would become a full professor.

Because of the promising utility of genetics in agriculture, Schiemann worked until 1931 in the newly established Institute for Hereditary Research. The institute was connected to the not very prestigious agricultural university. At the beginning of Baur's directorship of the institute, his reputation as a good scientist was not yet established. He had to prove himself, probably the more so because of his middle class background. He was not yet able to attract ambitious young men, because such men would for the time being choose more prestigious disciplines. Therefore, to be able to do sizable investigations, he could not count on the usual group of investigators but had to rely on newcomers, the first generation of university women. Schiemann and the other, mainly female, assistants worked on the foundations of the new field of genetics. They built up the institute and helped to raise the scientific prestige of their patron. Schiemann not only developed her own research program, she was also an important force for the continuity and prestige of the institute through her participation in its removal in 1915 and through her contribution to the organization of the international congress in 1927. Baur profited a great deal from her scientific and organizational abilities. That in 1927 he took the opportunity to establish the Kaiser-Wilhelm Institute was an indication of the enhanced prestige genetics had gained. Baur could then offer young male investigators more attractive positions.

Bonnevie's case is different. Clearly, an international orientation in research was considered important at the University of Christiania. To have scientific contacts Norwegian scientists had to look beyond national borders, because Norway had only one state university. Bonnevie profited from the fact that students and staff of the University of Christiania received opportunities to go abroad to participate in

well-known research groups and to bring that expertise home. Later, when Mendelian genetics had become a successfully accepted field, she took the initiative to establish an institute dedicated to human heredity. Thus she became involved in those successful developments.

In the new institutes it was not difficult to find fruitful research topics in genetics. Tine Tammes worked at the applicability of the Mendelian laws on continuous characters and studied this question by means of the agriculturally interesting flax plant. Schiemann was engaged in the role of mutations and investigated the genetics of the agriculturally interesting barley plant. Bonnevie started with physiological genetics investigations, but redirected her research and started to study Mendelian genetics in humans. Human genetics became a popular new field of investigation in Norway, because of its possible relevance for eugenics. All three worked in the new field of genetics on a few of the many questions requesting an answer.

Patronage

Now we turn to the factor of patronage. That factor was decisive in all three cases, but very differently. In the case of Tine Tammes the positive influence of a patron was obvious. She was fortunate to have Moll as her teacher, with his liberal attitude towards intellectual women. He ensured that she would have a scientific career commensurate with her abilities. He enabled her to work with the famous Hugo de Vries who worked on questions of heredity. Moll took great pains to obtain a job for her and to give her a promising research subject. That she did not start work in an adequate position elsewhere had partly to do with the fact that an unmarried middle-class woman should be looking after her parents. Then Moll organized work for her at his new laboratory. He could fit her in with his plans to establish an agricultural institute. He carefully cleared away all the obstacles in her education to turn her into a serious candidate for a professorship. When he retired his successor took this task over.

Patronage was necessary in the beginning of Bonnevie's career. When she started work in the Zoological Laboratory, the curator Hjort made grateful use of her abilities and collaborated with her. However, if we must point to a patron, then it should be the head of the laboratory, Sars. Fortunately for Bonnevie, he belonged to the liberal élite of Christiania. When the curator's position became vacant in 1900, he chose Bonnevie out of four applicants, although it seems possible to

argue that her direct competitor was at least comparably qualified. Once appointed curator, she took destiny in her own hands and successfully became indispensable. We don't know how intentionally she did that. She asked for the opportunity to teach and made a big success of it. Through her successful application for the professorship in Bergen she had demonstrated that she was qualified for a professorship. As a result, the students and professors concerned at the University of Christiania swung into action to get her appointed. Already her position was so strong that she no longer depended on a single patron.

The case of Schiemann adds a warning to the need for patronage; it shows the vulnerability of such dependency. Baur gave Schiemann the opportunity to work in his recently established institute. Unfortunately for her, she depended on a person who not only was immersed in his own career, but did not mind dropping his staff, to quote her own words, "like dropping research projects when new and more important successors emerge." He turned out to be untrustworthy, because everyone was convinced that she would become a department head in the new institute, but ultimately that did not happen. After Schiemann's split with Baur in 1930, her career would stagnate for a lengthy period, during which time she did not always earn a reasonable income. She experienced how painful and difficult life can be when patronage vanishes. To explain how, nevertheless, she did manage to move on in her career after leaving the institute, one must take into account that she had already become a recognized scientist who had built her own collegial network. Other scientists were willing and able to give her other possibilities, although these were comparatively poorly rewarded.

In all three cases we see the necessity of a patron. We also observe that it is risky to remain dependent on one person. When circumstances change, such a patron's attitude can change. It is important to strive for independence. We see the success of that strategy most clearly in the case of Bonnevie.

Closing Remarks

We close with the observation that this new field of genetics, like other fields emerging at the time, benefited from the input of intelligent and dedicated female researchers. These women contributed greatly to make their field a successful scientific discipline. We chose to discuss women in genetics who ultimately became professors. Bonnevie was evidently the most successful; four years after her appointment as extraordinary

professor, she became full professor. Tammes and Schiemann became and remained extraordinary professors. These cases nonetheless demonstrate the emerging chances for women for a university career. It should be noted that it was not enough that women were intellectually inquisitive and determined; hindrances had to be cleared away. The women had to deal with their parents' attitudes, which in all our cases was not optimal. The women had to surmount their inadequate secondary education. That they were ultimately successful in becoming professors could be explained by the range and variety of positive factors. When one factor proved not very effective, another factor could exert its influence. The relative importance of the factors depended on the local circumstances. The factor of patronage was absolutely necessary, but it appeared to be equally essential to become strong by one's own means, because patronage can disappear when circumstances change. It was easier to become independent in a context open-minded to women scholars than in an unfriendly environment. In that respect Bonnevie's circumstances were relatively better. In addition, all three profited from the new opportunities for women to have a university career. They worked and studied in environments which, although different from one another, were positive towards them, at least in the beginning. That genetics was a new field also worked out well for them. Obviously in the case of Tammes and Schiemann, their connection to agriculture was important, as was also the case for Bonnevie in her connection with eugenics.

Two of our three women, Tammes and Schiemann, would probably not have succeeded in becoming extraordinary professors, let alone full professors, after genetics joined the establishment. But they were professors before that happened. Our cases show clearly that a new field first relatively open to women closes its doors to them once it becomes established. A comparable phenomenon is demonstrated by the historian Marsha Richmond in her discussion of the Cambridge geneticist William Bateson and his coworkers, who were first dominantly female, but later dominantly male.⁹⁴

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⁹⁴ Richmond, 2001.

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