



## Janaki Ammal, C. D. Darlington and J. B. S. Haldane: scientific encounters at the end of empire

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**Abstract.** Right from the beginning, genetics has been an international venture, with international networks involving the collaboration of scientists across continents. Janaki Ammal's career illustrates this. This paper traces her scientific path by situating it in the context of her relationships with J. B. S. Haldane and C. D. Darlington.

**Keywords.** science; empire; India.

### Introduction

Genetics as a discipline was slow in coming of age. Even in the 1920s, as the eminent woman cytogeneticist Barbara McClintock was to note, genetics had not yet received general acceptance: 'twenty-one years had passed since the rediscovery of Mendel's principles of heredity. Genetic experiments, guided by these principles, expanded rapidly in the years between 1900 and 1921. The results of these studies provided a solid conceptual framework into which subsequent results could be fitted. Nevertheless, there was reluctance on the part of some professional biologists to accept the revolutionary concepts that were surfacing' ([https://www.nobelprize.org/nobel\\_prizes/medicine/laureates/1983/mcclintock-bio.html](https://www.nobelprize.org/nobel_prizes/medicine/laureates/1983/mcclintock-bio.html)). The intellectual effervescence and the discovery of cytogenetics produced three remarkable individuals whose life criss-crossed in new and interesting ways in the 1930s, 1940s and 1950s in the pursuit of science. Two were European men at the peak of their careers in the biological sciences and the third was an unknown Indian woman scientist of mixed race and so-called lower caste origins. Their equivocal encounters and discussions on biology, eugenics, philosophy and politics highlight the cosmopolitan nature of science in the empire, a cosmopolitanism that is surprising given the dominant racial ideas at the time and one that was lost as narrow utilitarian perspectives of a nationalist science began to dominate after Indian independence. One writer has noted that the science of

genetics had from its inception been an international venture with collaborations and international networks of science across continents (Krementsov 2005, p. 3). This paper traces that trajectory primarily through the lens of the relationship between the Indian woman cytogeneticist E. K. Janaki Ammal, the population geneticist, J. B. S. Haldane and 'the man who discovered the chromosome', C. D. Darlington (Harman 2004).

### Equivocal encounters

Ammal was born into a *thiya* family of north Malabar in 1897 (Thurston and Rangachari 1909, p. 58).<sup>1</sup> Her mother Devi was the mixed-race daughter of John Child Hannyn-ton of the Madras civil service. Her father, E. K. Krishnan, was a stalwart of the local *thiya* community who had risen to the position of subjudge in the Tellicherry court. E. K. Janaki, as she was then known, had her schooling at the Sacred Heart Girl's High School in Tellicherry, followed by a B. A. honours in botany from Queen Mary's College, Madras. Missionary education thus provided a way out of caste and race restrictions. The union between Krishnan and Devi had been frowned upon by both sides of the racial divide. 'White *thiyas*', as the mixed races came to be known, were seen as impure by their pure *thiya* brethren and marriage alliances for the children were hard to come by. It was in these circumstances that Janaki chose a life of scholarship over marriage.<sup>2</sup> With it came geographical dislocation



**Figure 1.** Janaki Ammal at the John Innes u.d. presumably in the 1940s (source: The John Innes Archives, courtesy of the John Innes Foundation).

and an opportunity to move away from her constraining background in terms of gender, caste and race. Her life in science had begun. Her marginal status as a woman and as a lower caste, mixed race, Indian was to be transformed in the process. It was while working as a lecturer at the Women's Christian College, Madras, in the early 1920s that she received a scholarship from Michigan University where she received an MA in 1925 returning again to complete her D.Sc. in 1931. While at Michigan, she worked under Harley Harris Bartlett, Professor of Botany, who had a broad spectrum of scientific interests from botany to the history of science and who was to inspire her later forays into ethnobotany.<sup>3</sup> On her way back to India in 1931 she spent a year at the John Innes Institute at Merton near London, where her encounter with C. D. Darlington signalled the start of a long scientific friendship.

On her return to India in 1932 she was appointed a professor of botany at Maharaja College of Science, Trivandrum, followed by a five-year stint at the Sugar Cane Breeding Institute, Coimbatore where she devoted herself to genetic studies contributing to the breeding of sugar cane. She travelled to Edinburgh in 1939 to take part in the 7th International Congress of Genetics and was compelled to remain in Britain for the duration of the war. From 1940 to 1945 she was assistant cytologist to C. D. Darlington at the John Innes Institute (figure 1). It was here that she worked on the origin and evolution of cultivated plants resulting in the *Chromosome atlas of cultivated plants* which she coauthored with Darlington and which became an important source for cytological work on the economic plants of the world. She returned to India in 1948, met Nehru on the aeroplane, and her career as a national scientist began after she finally came home in 1951. By 1955 she was the Director of the Central Botanical Laboratory of the Government of India at Lucknow. She was to become Fellow of the Linnean Society of London, the Royal Geographical Society, the

Asiatic Society of Bengal, the Royal Asiatic Society, London and the Indian Academy of Sciences. In fact, Janaki Ammal was one of the founding members of the Academy, and the first woman member. An honorary Legum Doctoris was bestowed on her in 1955 by the University of Michigan. C. S. Subramanian, a scientific contemporary of hers who was the Director of the Centre for Advanced Study in Botany at the University of Madras has written about her passion for plants, crop plants, garden plants, plantation crops, medicinal crops, and tribal plants (Subramanian 2007). He saw her as an original thinker doing 'epochal' work on intergeneric hybrids such as *Saccharum/Zea*, *Saccharum/Erianthus*, *Saccharum/Imperata*, and *Saccharum/Sorghum*. Her pioneering work was on the cytogenetics of *Saccharum officinarum* (sugarcane) and interspecific and intergeneric hybrids involving sugarcane and both closely related grass genera and very distantly related ones such as *Bambusa* (bamboo). Her studies on chromosome numbers and ploidy, as he noted, were directed to ascertaining the role of hybridization in the evolution of flowering plants, work that she had started with Darlington. As the first salaried female staff member based at the garden of the Royal Horticultural Society at Wisley in 1945 she undertook investigations of colchicine and its use in inducing polyploidy (Royal Horticultural Society herbarium, *Timeline*). The focus of her work on polyploidy and plant evolution continued after her return to India where she worked on the genera, *Solanum*, *Datura*, *Mentha*, *Cymbopogon* and *Dioscorea*, besides a range of medicinal and other plants (Subramanian 2007). The confluence of Chinese and Malayan with Indian floristic elements in northeast India led, she believed, to natural hybridization between these and contributed greatly to species diversification. As Subramanian recorded 'though cytology was her forte, her work embraced genetics, evolution, phytogeography and ethnobotany' (Subramanian 2007).

Janaki Ammal's early professional career was associated closely with Cyril Dean Darlington (1903–1981) who his biographer has described as 'belonging to the great school of British geneticists, evolutionists and biological statisticians produced by a country basking in the afterglow of the eminent Victorians, Charles Darwin and Francis Galton.' Under William Bateson, cytological research at the John Innes was arguing for the central principle of Mendelism in heredity through breeding experiments (Harman 2004, p. 22) similar to Edmund Wilson's experiments across the Atlantic in Columbia. But there were serious differences: Bateson was rejecting the chromosomal theory of heredity and under his directorship, research at the John Innes that found exceptions to the chromosomal basis of genetics was encouraged. Darlington's early work under Bateson and Frank Newton was on polyploidy (the existence of more than two homologous chromosomes in the chromosome complement) (Harman 2004, p. 34). His first article in *Nature*, which later became known as Darlington's rule, was that there was a negative correlation between the fertility of the polyploid and that of the diploid from which it arose (Harman 2004, p. 52). But Darlington was moving away from Bateson's work. In 1930, he began to make significant contributions to the understanding of the relationship of 'genetic crossing-over and the microscopically observed events that the chromosome passed through during meiosis'. His first cytological work, *Recent advances in cytology* (1932) was a landmark. In it, he exposed the dynamic qualities of chromosome behaviour and their role in genetics and evolution of organisms. In his last chapter, he argued that not only was heredity leading to evolution, heredity itself was subject to evolution. Meiosis, recombination and breeding, the constituents of the genetic system were not adaptations to the immediate environment but adaptations to the environment of future generations. His 1939 book, *The evolution of genetic systems*, would be hailed by some as a fundamental contribution to evolutionary thought.

Darlington's 'genetic systems' were different from the mathematical population genetics of J. B. S. Haldane, and R. A. Fisher who were colleagues at the John Innes. In 1928, Haldane a man of prodigious intelligence with an interest in population genetics and human genetics, arrived at the John Innes. Darlington formed a close friendship with Haldane, spending long hours with him discussing genetics, politics and eugenics. Barbara McClintock was to note after meeting Darlington on her way back from Germany in 1933 that he seemed to have set aside their scientific argument and was charming 'All in all, I won't register this period as too much of a success although I gained considerably in "contacts". (This is Darlington's pet phrase; to be said with a meaningful smile.) Which reminds me that I saw Darlington in England. He was quite as ever. Our personal animosities were completely forgotten so that we had a swell time. He wrote to me

recently that he had been in Russia. He seemed to be much impressed with the possibilities there and even thinks of spending more time there' (Barbara McClintock Papers, Folder, 3, 3, 1934).

Increasingly, plant geneticists were becoming interested in human genetics. Eugenics, a term that meant 'good breeding', was coined by Francis Galton in 1904 as the 'science which deals with all influences that improve the inborn qualities of a race; also with those that develop them to the utmost advantage...If farmers and flower fanciers could improve animals and plants through selective breeding, could not the race of men be similarly improved' (Galton 1904). J. B. S. Haldane and R. A. Fisher had adopted a mathematical population approach using the gene not the chromosome as the functional unit of selection (Harman 2004, p. 93). What was at stake for biology were as Harman notes 'the hidden boundaries between cytology, genetics and evolutionary theory' (Harman 2004, p. 104). Darlington was a cytologist interested in evolutionary theory. He had never stepped out into the field and many of his ideas especially in the US continued to be treated with caution. Later in his life, Darlington would turn to the subject of history becoming, as his biographer noted, 'one of the most fascinating and controversial exponents of the socio-biological approach to human culture' (Harman 2004, p. 2).

Already in the 1930s, he was interested in the variety of human cultures. In 1933, he had visited India for the first time; its caste system and tribes fascinated him. Ammal had encouraged his interests and he noted the scientific work of the sugarcane breeding institute where Ammal worked in positive terms noting that 'the hybrids seemed likely to revolutionise sugarcane growing in India and elsewhere'. In 1937, he visited India again and he had begun reading on a variety of subjects from the history of different peoples, empires, religions and the behaviour of man (Harman 2004, p. 196). In 1960, Darlington having returned to his interest on the origin and structure of society pestered Janaki for information on caste in India and, in particular, the distribution of 'criminal castes'. He had moved on from the study of chromosomes to social genetics and to an interpretation of language, class, race and society in biological terms.

Darlington had always been interested in the link between man, culture and biology. In 1927, he had joined the Eugenics Society. The invitation letter to the society noted that 'It is widely appreciated among biologists in general that the neglect of biological and genetical knowledge in modern legislation may lead to incalculable damage to our own people and those of other civilised communities' (Harman 2004, p. 194). In 1947, along with R. A. Fisher, he cofounded *Heredity: an International Journal of Genetics* (Harman 2004, p. 208). Fisher, like Darlington and others of their generation including Haldane, was interested in the application of genetics to man. As eugenicists they believed that genetics needed to

become the causal framework, not only of biology, but of the social sciences too. For the first 40 years of the century, as Majumdar noted, genetics was synonymous with eugenics (Mazumdar 1992). Between the wars 'it was still possible to be a scientist, a socialist, a meritocrat and a eugenicist.'<sup>4</sup> The most advanced mathematical methodologies employed in genetics were embraced in the 1930s by critics of the way in which genetical theory was being misused, led by Lancelot Hogben, Haldane and Lionel Penrose. Each of them was—in his own way—appalled by the crude class prejudices manifested by mainline eugenics. What was ironic was that these critics sought to produce a truly objective science of genetics by equipping themselves with methodologies created by the supporters of eugenics in Germany, where as we know the programme was pushed to its ultimate extreme (Mazumdar 1992).

J. B. S. Haldane, who became the first Weldon Professor of Genetics at the University of London in 1937 was at the forefront of these debates. He is considered one of the founders of population genetics (which was to become a major component of the Modern Synthesis), which in essence combined Mendelism and Darwinism (Mayr and Provine 1980). An influential contribution to the field was his 1924 article the first in a series 'A mathematical theory of natural and artificial selection' (Haldane 1924; also see Wilmot 2017, this issue). Haldane also made significant contributions to biochemistry, physiology and human genetics (Dronamaraju 1986). In 1932, he was elected to be a Fellow of the Royal Society (Wilmot 2017, this issue). His outstanding contribution was in mathematical genetics where he mathematically dealt with problems dealing with Darwinian variation and established the relationship of Mendelian genetics to evolution.<sup>5</sup> A lifelong Marxist, he was critical of the Lamarckianism of anticommunist eugenicists such as E. W. MacBride. A committed geneticist and selectionist, his views like those of Darlington ran counter to the egalitarian and environmentalist emphasis of Lysenko's biology, which was strongly reminiscent of Lamarckian thinking and by 1948 had become official Soviet party biology (see DeJong-Lambert (2017), this issue, for details of Haldane's involvement in the Lysenko affair).

Trofim Lysenko denied Mendelian genetics, proposing his own 'Michurinist' genetics (Michurin was a Russian plant breeder who had dismissed formal scientific methodology), which did not view the gene as the unit of heredity, but rather held the Lamarckian view that the hereditary traits of plants could be influenced by external conditions. Despite his unscientific theory, Lysenkoism had considerable success in increasing the yield of industrial plants, such as rye, wheat, cotton, potato and sunflower, which led to his appointment as the head of the Odessa Institute of Genetics and Plant Breeding in 1935. Notwithstanding his limited biological training, he questioned theoretical research and its benefits for the Russian poor. Bourgeois scientists he argued were wrecking the socialist effort. By

1948, Lysenkoism was taught in the USSR as a fact (Krementsov 2005). Haldane as a communist since the late 1930s, a member of the Communist Party since 1942 and a member of the executive committee since 1944 (Paul 1983) was initially sympathetic towards Lysenko's arguments (Haldane 1940) arguing that the real content of the proletarian demand for equality is the demand for the abolition of class... any demand for equality beyond that 'of necessity passes into absurdity' (Harman 2004, p. 147). As Harman notes, 'Lysenkoism during and after the war and until the summer of 1948 posed little problem to the broader goals of the scientific left, that of a planned economy and that of science as a model and a vehicle for human needs. The writer Paul suggests there may have been more Lysenkoists in India, France and Brazil than England, but in England people were forced to choose between science and communism (Paul 1983). C. D. Darlington however, was vocal in his criticism of Lysenkoism (Harman 2004) arguing that, 'a government which relied on the absence of inborn class and race differences in man as the basis of its political theory, was naturally unhappy about a science of genetics which relies on the presence of such differences' (Harman 2004, p. 151). Other critics such as R. A. Fisher also condemned Lysenko (Paul 1983). In the 1940s, Haldane and Darlington fell out over Haldane's failure adequately to understand the threat posed by Lysenko and his stranglehold over Soviet science. In Stalin's Russia, Mendelian genetics was exiled and its practitioners punished. Many Marxists who had been sympathetic to the socialist experiment joined the anti-Soviet campaign. However as noted, Haldane, due to his Marxist allegiances, showed a remarkable reluctance to damn Lysenko, while Darlington and other western geneticists were openly critical of Lysenko especially in the journal *Heredity* which he had started with Fisher in 1947 as the journal for the genetics Society (Lewis 1983). The copyright for the *Journal of Genetics* had been bought by Haldane in 1946 (Clark 2013), and this was a major determining factor in their decision to start a new journal which was described as being 'inevitable'.<sup>6</sup> By the late 1940s things were changing, in the face of overwhelming evidence against Lysenko; Haldane withdrew from Communist Party activities before finally leaving it (Harman 2004, pp. 154–155). It was the invasion of Suez in 1956, however, which he himself credited as his reason for leaving the UK (Clark 2013).

The relationship between Darlington and Haldane was at an all-time low. Haldane moved to India in 1957 over the Suez crisis, denouncing western imperialism, and joined the Indian Statistical Institute. He took the *Journal of Genetics* with him and ran it with his wife Helen Spurway, inviting Janaki Ammal to contribute to it.<sup>7</sup> Ammal had first encountered Haldane in England through Darlington and while she was at the John Innes institute for the duration of the war, she had sent him an urgent message asking to borrow a microscope for her cytological work which as it transpired he could not provide.<sup>8</sup> An academic

relationship and a friendship followed with meetings, letters and exchange of gifts over a long period. In 1955, Haldane wrote to her at the Central Botanical Laboratory in Lucknow, thanking her for the gift of a lighter and for her paper on the subsistence economy of India. He questioned her assertion that the ‘Nambudris were a pure line’ referring to their joint enquiries on the population genetics of India which was an interest all three of them shared.<sup>9</sup> After Haldane’s arrival in India, there was a joint visit with his students in 1961 that included a visit to Allahabad at Ammal’s invitation where she showed him her laboratory and several slides of her chromosomes of Indian plant species and took the troupe on ‘a fine excursion into the countryside outside Allahabad where Haldane, against the advice of a local Brahmin, jumped into the river Ganges which was supposed to contain the freshwater crocodile and had ‘a swim’ (Dronamaraju 1985). Ammal recorded her impressions of the visit in a letter to Darlington ‘I wish Eileen<sup>10</sup> would return to India and continue her anthropological research. She would make a good partner for Prof. JBS, who by the way\_ got his Indian citizenship the other day\_ I wonder if he will also turn Hindu? When he visited Allahabad I drove him and Helen over to Benares and he was very respectful in front of the Shiva Temple and even more respectful when we came to the Annapurna shrine\_ the temple, dedicated to the wife of Shiva ‘I like the ladies’ he said and seeing me standing rather aloof he turned round and chided me saying \_ ‘you are not a Hindu, you are a Buddhist \_ Janaki!’ Then the two of them and a student of theirs waded through the filth of the temple alley in search of a betel (shop \_ to chew pan) I had a difficult time trying to keep the temple bulls from charging JBS ... garlands the one the priest gave him at the temple of Shiva–Viswanath.’<sup>11</sup>

However, as the relationship between Darlington and Haldane soured, the relationship between Ammal and Haldane was often affected by their animosity as is reflected in the letters. Interested in anthropology, Haldane was critical of the new journal *Mankind Quarterly* and its crude racial typologies edited by Robert Gayre who had Ruggles Gates, a friend of Darlington’s on the editorial board, noting in a letter to Ammal that ‘I should avoid even correspondence with any journal with which RR Gates is connected ... I am only surprised that it does not have C. D. Darlington on its editorial board. In a more humorous vein he added, ‘an editor called Gayre of Gayre, has classified men by their hayre, in Mongols it’s straight, in Negroes crenate, in Caucasians curly and fayre.’<sup>12</sup> It is clear that she sent a copy of this letter to Darlington as it is to be found also in his papers.

Haldane became an Indian citizen in 1961.<sup>13</sup> Disillusioned by British politics, he was attracted by Nehru’s neutralist policy (Rao 2015). Haldane and Spurway were both also offered jobs in 1957 at the Indian Statistical Institute at the point at which Haldane was close to retirement from UCL (Dronamaraju 2010). He like Darlington

had always had a deep interest in Indian history, religions, languages and cultures and would often quote passages in Indian languages during lectures (Rao 2015). His first visit to India had been in 1917, when he was recovering from wounds received in Mesopotamia (Rao 2015) and in 1918 he formed a resolution to return once it had achieved independence (Rao 2015). The Haldane papers provide evidence of Haldane’s long interest in Indian politics and his association with the India League, the India relief committee and the Indian Science Congress Association at the cusp of independence. This led to his acquaintance with V. K. Krishna Menon from at least as early as 1943. Haldane also became a member of the Indian relief committee in 1943, networking with various Indian academics, including P. C. Mahalanobis of the Indian Statistical Institute, with whom he would later work with in Calcutta. In 1946, Mahalanobis invited Haldane to visit him in India. He was unable to make the journey, as Calcutta in 1946 was going through partition. Haldane commented on this ‘You have been having a terrible time in Calcutta, however, I hope things are better now, and that Nehru will be able to straighten things out. However he has a terribly difficult job ahead of him.’<sup>14</sup> He finally visited India in December 1951 and was invited to a dinner with a selection of politicians and academics including Nehru and S. N. Bose.<sup>15</sup> Over the next five years before moving to India, Haldane was in communication with a number of Indian academics and politicians, including R. Narasimhan, of the sugarcane breeding institute, S. P. Roychoudhuri, lecturer in Calcutta university, Megnath Saha and S. S. Bhatnagar. Writing to Bhatnagar for funding the laboratory of Roychoudhuri, he made a plea that the study of Indian species was invaluable as their cytological behaviour had no close parallel in Europe or North America.<sup>16</sup> He was invited to conferences, asked for advice and sent papers for feedback. In 1953, S. L. Hora of the National Institute of Sciences of India thanked him for the best Indian dinner he had in London since he left India. Clearly even before he left England permanently he had a taste for Indian food. This was vastly different from Darlington whose early forays into Indian food, he described as indigestible.<sup>17</sup> On his arrival in India, Haldane became a research associate at the Indian Statistical Institute from 1957 to 1961. This is a period well covered in the secondary literature (Dronamaraju 2010). While at the institute, he helped to set up units in the research of genetics and palaeontology (Dronamaraju 2010). Later he moved to Bhubaneswar where the Chief Minister of Orissa built him an Institute for Genetics and Biometry (Dronamaraju 2010) and where he played an important role in strengthening international scientific relationships (Rao 2015).

In India, Haldane saw the Darwinian theory of evolution from a fresh perspective, noting that Hinduism did not distinguish between humans and other animals—unlike in Christian theology.<sup>18</sup> Ammal wrote to Darlington in 1961, ‘Haldane was very much in the papers lately over a fast

he undertook for a silly reason ... he comes to scientific meetings in pyjamas and wears dhotis—i.e. loin cloth at home chews betel leaves while Helen smokes beedis and sips gin.<sup>19</sup> She included with this two newspaper cuttings with the letter showing, a picture of Haldane sitting down reading with the caption ‘Prof J. B. S. Haldane at work in his house at Barrakpore Trunk Road, Calcutta, on the third day of his fast. His left ankle is in plaster as a result of an injury sustained during his recent visit to Ceylon for the science congress there—Statesman.’ The headlines noted that ‘Haldane’s fast enters the fourth day, Calcutta, Jan. 20—Prof J. B. S. Haldane, the British Scientist continued his fast for the fourth day today in protest against what he calls the “discourtesy” of the United States Information Service here says PTI.’<sup>20</sup> Clearly, Haldane was causing a mild sensation in India.

The equivocal encounters of these three giants of biology is a neglected story of the history of science though no less remarkable for the ways it transgressed, gender, race and national boundaries. Through their interactions, meetings and discussions over a 50 year period the three individuals showed a strong friendship and respect for each other’s scientific endeavours highlighting the cosmopolitanism of science at the end of empire. For Haldane, India became the new centre as he relocated for his scientific work to Calcutta in 1957 and Bhubheshwar in 1960. For Ammal, notwithstanding the many hurdles placed in her way by the scientific patriarchy she crisscrossed continents basing herself in India from the 1950s, challenging the narrow utilitarian constraints of a nationalist science, opening the doors to new horizons for university research in her pursuit of cytogenetics and ethnobotany and through her institutional leadership with regard to the Botanical Survey of India. For Darlington, his patronage of Janaki Ammal included an interest in India which was revived in the 1960s as he moved on from the study of chromosomes to social genetics and to an interpretation of language, class, race and society in biology. Their relationship, their discussions and their prejudices are documented in their letters to each other and to other scientists indicating a fascinating period in the history of science.

### The patriarchy of science

Ammal’s range of academic contacts and colleagues extended around the world. Her extensive scientific correspondence extended to scientists and academics such as Haldane; H. Newton Barber, Professor of Botany at the University of Sydney who sent his student Constance Margaret Eardley later to become lecturer in Botany in Adelaide to work with her at Wisley; Pio Kollar, Hungarian geneticist and Professor of Cytogenetics in the Institute of Cancer research in London; several Edinburgh-based and Kew-based botanists such as B. L. Burtt; and physical anthropologists such as Ruggles Gates and Eileen

Mcfarlane. She kept a copious correspondence with many of these, but few of her letters and collections have survived.<sup>21</sup> Her Indian scientific friends included eminent agricultural scientists such as M. S. Swaminathan, and B. P. Pal geneticist and plant breeder and Director of the Indian Council of Agricultural Research. She valued her personal friendships with many of them and called Swaminathan and Pal her ‘good friends.’<sup>22</sup> To her old friend Pio Koller, her correspondence included references to his daughter Christa and academic ideas.<sup>23</sup> Her experience of translocation and geographical displacement provided opportunities for building international friendships and she worked successfully as a respected female scientist in many public institutions normally the preserve of men.

The scientific and sometimes highly personal correspondence between Darlington and Janaki Ammal is preserved in the Bodleian Library in Oxford and provides a remarkable insight into the nature of a very particular scientific relationship that spanned different continents and crossed gender and racial barriers. Her early letters to Darlington reveal an independent thinking, young woman scientist with a deal of self-respect and self-esteem. When she joined the John Innes institute in 1931 to work with Darlington, she was joining one of Britain’s most vibrant biological communities. By the 1930s it had become Britain’s premier Institute for genetical research, contributing fundamental insights into the chromosomal basis of heredity and its role in evolution. In January 1931, Darlington was beginning to write his masterpiece, *Recent advances in cytology* which was also an attack on Lamarckian inheritance planting him firmly in the neo-Darwinian camp. Darlington had become a major force to reckon with in the field cytogenetics (Harman 2004, p. 83). As head of the Department of Cytology, with 15 people studying under him, he had created the largest school of its kind in the world. One of these researchers was E. K. Janaki Ammal. On 29 May 1931 she wrote an introductory letter to him noting that she was ‘anxious to do the cytology of a triploid eggplant’.<sup>24</sup> By the end of the year she was working on *Saccharum–Sorghum* hybrids noting eloquently ‘There is a terrific amount of variation in the F1’s and some of the dwarfs and pale fellows look as though they are aching to disclose something cytologically and genetically’.<sup>25</sup> Darlington was typical of the scientific mentors of his period in that in extending his largesse to female employees under him, he often formed intimate relationships with them, if only briefly.<sup>26</sup> Janaki was to prove no exception and in three of her letters written in the 1934 she indicates her emotional involvement with him.<sup>27</sup> Darlington’s diaries records his lunches with Janaki in Chelsea in 1935, with ‘crumpets and curry.’<sup>28</sup> By 1935 their affair was over and Darlington had moved on, marrying his student Margaret Upcott in 1937. This was only to be a brief passionate interlude but the relationship was one that was to dominate Ammal’s life. As noted by Abir-Am and Outram, the progressive attitude of some

male scientific mentors of women scientists often related to some form of emotional involvement leading to collaborative work. Women scientists tended to follow this route, rather than taking on the precarious position in science that would have resulted in the absence of a male mentor.<sup>29</sup> Other letters to Darlington followed, this time from India where she had returned in 1932, and from the Imperial Sugar Cane Institute in Coimbatore where she was working in 1934. 'I shall try to accomplish something in *Saccharum* cytology so as to get an open sesame to USSR. My new microscope arrived last week (Lietz binocular). I have fixed enough material to keep me engaged for three years.<sup>30</sup> Clearly Russian genetics and cytological studies were highly rated before the Lysenko affair. In 1938 she wrote to Darlington's new wife Margaret also a botanist and his former student on her new paper 'I am using the term triplopolypoidy as suggested by CDD at Calcutta to describe triploidy within a polyploid series. I should however wish to have his full acceptance of the meaning before I do so\_ will secondary Triploidy do? I would like to send this note to *Current Science* (which is India's - *Nature*) when you send it back.'<sup>31</sup>

Despite her active work in the field, Ammal faced several hurdles from the male scientific establishment in India and in Britain and even from Darlington himself as the correspondence in the Bodleian reveals. In one letter in August, 1938 she notes of the visit of Reginald Ruggles Gates to Coimbatore; 'It has taken seven long months to undo the harm that Gates did in the course of a simple day spent in Coimbatore. Mr Venkatraman was completely taken in by the 'Professor's keen interest in the work done at Coimbatore'—his fund of information and his gracious manner. Hence the doubt expressed not to me but to Venkatraman about the validity of the *Saccharum-Zea* cross stuck in the expert's brain and my note to *Nature* was not sent up to the Director of Agriculture for the necessary permission to publish it outside India—I very nearly decided to leave this station as a result of all this — and life became very complicated— however I refused to be defeated and I am glad to report that Venkatraman is at last convinced that the cross is genuine'. The note to *Nature* was finally published in 1938.<sup>32</sup> The same letter went on to say 'I wonder whether I shall be able to attend the genetic Congress next year. My five years contract with the Imperial Council of Agricultural Research ends in May 1939. I hear it is going to be extended for another three years but after the way Venkatraman has been treating me I do not wish to continue here. What is the use of working if I find it so difficult to get permission to publish my findings?'<sup>33</sup> She was referring here to the director of the Sugar Cane Breeding Institute T. S. Venkatraman, who, with C. A. Barber, had initiated research in sugar cane breeding. Venkatraman had produced his drought and disease resistant Coimbatore canes CO 419 raising the prestige of the institute.<sup>34</sup> However, he was not averse to blocking the work of Janaki Ammal. Darlington was also not above

damning Janaki Ammal's work with faint praise. When John Russell, Director of the Rothamsted Experimental Station, wrote to him on 10 May 1937 noting that he had met her in Coimbatore and enquiring; 'could you kindly tell me whether her work seems sound, and whether it is simply in the nature of a student's exercise or can be dignified with the title of research?'.<sup>35</sup> Darlington's reply was indicative of the lack of support, even jealousy that Ammal routinely faced within the male scientific establishment: 'The question of Janaki Ammal seems to me to be part of a larger problem. Practitioners of cytology in India are very numerous, but cytological work of outstanding interest is unknown. The reason for this seems to be that Indians go in for cytology because they think it is a matter of technique and needs no thought otherwise. But cytology has begun to require a good deal of thought during the last few years. The job has not turned out to be what they thought it was. Therefore when I say Janaki Ammal understands her work better than anyone else I do not mean to pay her a vast compliment. I think she is doing sound work and will continue to do so for some time' just because a great deal of elementary exploration in this field is necessary and she cannot fail to be of value to the geneticist working with her'.<sup>36</sup> He further noted 'I think it is a great pity that numbers of Indians come to this country to take PhD degrees in cytology just because they think it is an easy subject and, having obtained their PhDs which they never fail to do, return to secure a post in India. We refuse to take such people here.' This perception of Ammal by her mentor could be said to be part of the racialized world view held by men such as Darlington and the skewed nature of science at this time, to which we now turn.

### Eugenics and Race in the mid-twentieth century

In the mid-twentieth century eugenics, was a popular topic in fiction and nonfiction. Plant breeders, cult science fiction authors and evolutionary biologists wrote about it. Darlington, Ammal and Haldane were all interested in eugenics in the 1930s and its study of the practice of selective breeding as applied to human beings. Ammal joined the British Eugenics Society in 1932 and always retained an interest in eugenics. She had willingly obliged Darlington in his collections on aboriginal races of India providing ethnographic details of tribes and castes in south India from the 1930s well into the 1970s. This had also become a developing interest of her own, as she had become interested in medicinal plants. In 1961 she wrote, 'I have posted three more books by Majumdar—you will find blood groups of castes in one'.<sup>37</sup>

Darlington as we have seen, had worked with R. A. Fisher one of the founders of the modern evolutionary synthesis, whose studies was his definitive statement of the mathematical basis of natural selection. Fisher's work of mathematical genetics ends with a long discussion of the problem of 'decreased fertility in the upper

classes' revealing the author's eugenical opinions of how to promote the breeding of favoured members of society and restrict others. It is a telling reminder of how eugenics was often seamlessly combined with other, perfectly valid, scientific ideas. Darlington's trilogy of books, *Genetics and man* (1964), *Evolution of man and society* (1969) and *The little universe of man* (1978) together integrated his eugenicist views and showed how little they had changed over a period of 15 years. His first book was more hard-line than the others but even in the last book he called for voluntary abortion for mothers and differential taxation to encourage certain parts of society to reproduce.

J. B. S. Haldane was not far behind. As the foremost populariser of science in his day, his books aimed to predict the scientific future. Its ideas were highly influential with the public and indeed many of the ideas in Huxley's *Brave new world* were taken directly from here. In the *Future of biology*, Haldane stated his view that a moderate level of voluntary eugenics is as certain as the world being turned into a human farm is unlikely. The link between man, culture and biology had captured the minds of both Haldane and Darlington. The letter inviting Darlington to join the Eugenics society in 1927 was signed by Huxley, Fisher and McBride (Harman 2004, p. 194). Darlington was beginning to make connections between the breeding of plants and that of men. His earlier travels to India with Janaki in the 1930s took on a new meaning as he began reading on history, language and archaeology. Castes fascinated him and the subdivision of races into smaller adaptive groups governed their racial evolution. For him 'man's intellectual and cultural evolution had led not to the absence of races found in other species, but to a special character in these races resulting from the unique character of artificial and natural selection.'

This slippage between race and culture had affected most of the post-Darwinian evolutionists (Stocking 1991, p. 185). Haldane had also been part of the eugenics movement in the 1930s. His text in 1932, *The Inequality of Man* had argued that with regard to physical characteristics, 'men are not born equal.' Further, he stated that, 'eugenics is at present the only possible way of improving the innate characters of man... the progress of biology in the next century will lead to the recognition of the innate inequality of man,' (Haldane 1932, p. 28). Haldane was to maintain his interest in difference even in the 1960s pushing for quantitative anthropology in India and commenting on the work of Dronamraju; 'Since you saw him, Dronamraju has revolutionised Indian anthropology. He has got good evidence that hairy pinna of the ear is Y-linked, as suspected for 50 years. Its frequency is about 6% in Andhra Pradesh, 20% in West Bengal, 37% in Bengal, 37% in Ceylon. It is a much better character than blood groups. He has got plenty more human results, but that is enough to be going on with.'<sup>38</sup>

Interestingly, however Haldane had shown his left wing tendencies by ending his earlier work and by noting that in future, mankind may be divided into castes like Hindus or termites, but in his time that recognition of innate inequality should lead not to less, but to greater equality of opportunity. In many ways, one can argue that as the 40s progressed Darlington went to the right of the eugenics movement while Haldane went to the left. The UNESCO, 1950 statement on race (following the political climate at the end of Nazi Germany) denied any relation 'between culture and genes', emphasising 'genetic dynamism rendering the concept of race scientifically meaningless', and rejecting 'the notion that races differed in mental capacity', or that there was a hierarchy of races and dangers for miscegenation. This UNESCO statement was recommended by Julian Huxley, J. B. S. Haldane and other eminent scientists. Darlington could not accept this view being of the firm belief that different races could never arise in similar environments and that groups differed in their innate capacities. For him intelligence varied among races. 'By trying to prove that races do not differ in these respects we do no service to mankind. We conceal the greatest problem which confronts mankind... namely how to use the diverse gifts and talents of each race for the benefit of all races... for if we were all innately the same, how should it profit us to work together. And what an empty world it would be' (Harman 2004, p. 237).

It can be argued that given the pervasiveness of eugenic ideas in the 30s and 40s it would have lasted longer had it had not been for Nazi Germany and the fact that post-War human genetics distanced itself from Nazi race based policies. Forward thinking scientists including Haldane, Penrose, Huxley with the notable exception of Darlington used modern evolutionary biology and genetics to combat racism. This group clearly included Janaki Ammal as is clear from her published work and correspondence. Darlington unfortunately had stubbornly refused to change his ideas. His 700 page book, *Evolution of Man and Society* detailed his complete philosophy of biological determinism and was received by the scientific community with shock, some reviewers called the views in it 'scandalous'. With the arrival of Watson in Cambridge in 1952 molecular genetics had taken over Darlington's science and a new trend in genetics and evolutionary biology had come to dominate. By 1975, many of Darlington's colleagues including Fisher, Haldane and Huxley had passed on. Haldane had died at the age of 72 of cancer in Bhubaneswar India. Ammal and Darlington soldiered on until the 1980s maintaining their friendship until Darlington's death in 1981 followed by Ammal in 1984. Their paths had gradually diverged. While Darlington continued to perpetuate his views that some people in society were more important than others, Ammal had returned to her interest in ethno-botany of tribal communities in India and forest conservation, supporting a project on saving the Silent

Valley in India. Steering clear of the politics of both Haldane and Darlington, Ammal was to continue her pursuit of empirical science at the laboratory in Maduravoyal in Madras until the very end.

### Notes on sources

- <sup>1</sup> Thiyas were toddy tappers by caste occupation historically and considered a lower caste in the Hindu caste hierarchy.
- <sup>2</sup> One sister E. K. Sumitra's married life was exceedingly unhappy and she was fed up of the reckless and wild ways of her husband. E. K. Sumitra's diary, personal copy.
- <sup>3</sup> Ammal to Darlington, 11 August 1978, Darlington Papers held at the Bodleian (hereafter DP).
- <sup>4</sup> Gavan Tredoux, *Two Geneticists: J.B.S. Haldane and C.D. Darlington*, <http://galton.org/reviews/tredoux-2000-pinc-haldane-darlington.html>. Originally published in *PINC*, April 2000. <http://www.cycad.com/cgi-bin/pine/apr2000/articles/tredoux-haldane-darlington.html>.
- <sup>5</sup> On the role of mathematical models as a framework for population genetics and dispute between Haldane the evolutionist Ernest Mayr, see Rao and Nanjundiah 2010.
- <sup>6</sup> Darlington to Fisher, 17th May 1946 DP.
- <sup>7</sup> The *Journal of Genetics* is one of the oldest English language journals in genetics, founded by W. Bateson and R. C. Punnett in 1910 and later edited by J. B. S. Haldane. See article by Rao (2017).
- <sup>8</sup> Ammal to Haldane, Haldane Papers 3/1/1/2/43.
- <sup>9</sup> Haldane to Darlington, Haldane Papers, 3rd October 1955.
- <sup>10</sup> She was referring to the physical anthropologist Eileen Mcfarlane.
- <sup>11</sup> Ammal to Darlington, DP, 3rd June 1961.
- <sup>12</sup> Haldane to Ammal, 30th December 1960, DP.
- <sup>13</sup> A good summary of his Indian period is to be found in Rao (2015).
- <sup>14</sup> Haldane Papers, 1946-07-25.
- <sup>15</sup> Haldane Papers, 1951-08-20.
- <sup>16</sup> Haldane Papers, 1952-08-04.
- <sup>17</sup> Darlington's diaries, DP.
- <sup>18</sup> Haldane's private research followed Darwin's botanical work. He saw Darwin's botany as his most original work. It included research into insectivorous plants, climbing plants, sexuality in plants and inbreeding in plants. He expected to find increased interdependence between plant species in areas of dense tropical flora, Dronamraju, 'Perspectives, JBS Haldane's last years: his life and work in India, 1957–1964', *Genetics*, May 2010.
- <sup>19</sup> Ammal to Darlington, 19th February 1960, DP.
- <sup>20</sup> The fast was undertaken to protest the fact that two researchers from the US information service not being allowed to visit him. See Ammal to Darlington, enclosing the newspaper cutting, 19th February 1960, DP.
- <sup>21</sup> Ammal to B. L. Burt, 12 October 1974, RBGE, see also Damodaran (2013).
- <sup>22</sup> Ammal to Darlington, 9 November 1979, DP.
- <sup>23</sup> Ammal to Pio Kollar, 16 January 1976, DP.
- <sup>24</sup> Ammal to Darlington, 29 May 1931, DP.
- <sup>25</sup> Ammal to Darlington, 14 November 1931, DP.
- <sup>26</sup> Harman (p. 85) mentions Ammal in his book dismissing her as one of many women Darlington had affairs with at this time that included another colleague Eileen Erlanson.
- <sup>27</sup> Ammal to Darlington, See Letters dated 10 August 1934, 31 October 1934, 22 November 1934. The 10 August letter was addressed as 'dearest Cyril; and signed of as 'yours passionately'. Ammal to Darlington, DP.

- <sup>28</sup> Darlington Diaries, 5.x.35.
- <sup>29</sup> Abir-Am and Outram 1987, see chap. 9–11 section 2 on the careers of mathematician Sofia Koral Evisham, physicist Marie Curie, astronomer, Cecelia Payne Gaponchkin.
- <sup>30</sup> Ammal to Darlington, 31 October 1934, DP.
- <sup>31</sup> Ammal to Margaret Upcott, 30th August 1938, DP.
- <sup>32</sup> Saccharum/zea cross, *Nature*, 1938.
- <sup>33</sup> Ammal to Darlington, 8 August 1938, DP.
- <sup>34</sup> T. S. Venkatraman (1884–1963) from 1912 to 1942 head of the Sugarcane Breeding Institute (knighted by the British in 1942).
- <sup>35</sup> John Russell to Darlington, 10 May 1937, DP.
- <sup>36</sup> Darlington to John Russell, 13 May 1937, DP.
- <sup>37</sup> Ammal to Darlington, 3 June 1961, DP.
- <sup>38</sup> Haldane to Ammal, 30th December 1960, DP.

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